ENERGY CONSERVATION

Energy Use and Conservation in Contra Costa County

ENERGY USE AND CONSERVATION IN CONTRA COSTA COUNTY, CALIFORNIA

CONTRA COSTA COUNTY
ENERGY RESOURCES AND CONSERVATION STUDY

Prepared by the
Contra Costa County Planning Department

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I. INTRODUCTION

A. OVERVIEW OF THE PROJECT

The Contra Costa County Energy Resources and Conservation Study was funded jointly by the U.S. Department of Housing and Urban Development and Contra Costa County through the Planning Department. Work was done during the period July 1975 to 1976 by the Planning Department staff and its consultant, Interactive Resources, Inc. This project was sought by the Planning Department in recognition of the need for increased energy awareness today and in the future. There was recognition of the present lack of energy data gathered in one reference and in a form usable for influencing public policy and for the project approval process, including compliance with the California Environmental Quality Act, which is a function of the County Planning Agency.

The Planning Department staff appreciates the cooperation received from the Pacific Gas and Electric Company, public agencies, the management of several public facilities and utilities, and the Study's Technical Advisory Committee.

B. PURPOSES OF THE PROJECT

The Energy Study's basic function was to analyze energy use and conservation measures from the local government point of view. In order to achieve this, several activities were undertaken, each represented in a section of this report, as follows:

1. Collection of data on energy use and analysis of historic factors which have led to existing energy use patterns and characteristics. (Section III, Energy Consumption)

2. Identification and evaluation of conservation potentials and the use of alternative energy resources, and determination of the impact conservation proposals could have on Countywide energy use. (Section IV, Alternative Sources and Section V, Conservation Potential)

3. Because of the great interest in the economics of conservation, the concern for continued high energy consumption, the opportunities for developing analytical methods, and in order to develop information which can lead to policies and appropriate incentives for conservation, one phase of the Energy Study was an economic evaluation of selected conservation measures. (Section VI, Economic Feasibility)

4. From the studies referenced above, ways in which the local government can contribute to conservation were developed. (Section VII, The Role of Local Government)

5. In order to be specific regarding basic conservation techniques in new development, and in order to be able to associate each technique with the appropriate step in project development, a section on Environmental Impact Report Guidelines has been prepared, including tables for analyzing short and long-term energy inputs and a checklist for identification of appropriate alternatives and mitigation means for each stage in project analysis. (Section VIII, EIR Guidelines)

C. USES OF THE REPORT

The report contains energy use data made available by Pacific Gas and Electric Company (PG&E). Contra Costa County Planning Department prepared information on the management of public facilities and services, plus data on present and future development information from the 1975 Countywide census and other Planning Department programs. The bulk of this information is contained in Appendix A which is intended to be a desk reference for Environmental Impact Report work as well as to be an indication to other data seekers of the sources, form, and availability of energy information.

Analysis and manipulation of data to reveal energy relationships, predict future residential use, and to evaluate conservation and economic values are also intended to aid in EIR work. The analytical methods are described in the Appendices so they may be used in this County in project analysis and are available to other jurisdictions with similar needs.

Section VII delineates the policies and actions which may be taken by local governments to contribute to conservation. They will be implemented through time on an incremental basis as energy-awareness increases. Other jurisdictions may follow these examples, but should look to local needs and local opportunities which differ from place to place.

Section VIII, EIR Guidelines, is based on a detailed report prepared by the Energy Study consultant, Interactive Resources, Inc., which is available from the Planning Department. Section VIII contains a checklist for relating steps in project development to conservation measures, and a method of calculating short and long-term energy for projects which has proved workable in test samples, and which may be used as a base for designing similar calculation methods for other types of projects or in other jurisdictions.

II. SUMMARY AND CONCLUSIONS

Over the last three decades Contra Costa County has shared in the national pattern of economic and institutional factors which have led to energy inefficiencies in everything from power generation plants to small motors. It is a premise of this study that the era of cheap abundant energy is over, and society may choose to invest in serious conservation programs, capitalize new conventional energy supplies, develop alternative non-depleting resources, or any combination of these. It is recommended that policies and economic incentives be directed toward early conservation. Conservation in new buildings can be achieved by mandatory State standards, but incentives are required to stimulate retrofit of existing buildings, which is needed for a significant degree of Countywide conservation.

Climates in the County are mild in winter, with some frost inland. Summer temperatures are more varied, grading from the cool marine west coast to the San Joaquin Valley with summer days frequently over 100 degrees. Because of the great topographic relief in the west and central County, due to the northwest-southeast trending Coast Range and Diablo Range which transect the County, microclimates abound, including cold air pockets, west and southwest facing slopes exposed to maximum solar radiation, and wind-swept ridges. The resulting mosaic of regional climates and microclimates creates not only varying needs for energy for space heating and cooling, but offers varying opportunities for conservation as well. The entire County is extremely favorable for solar energy and has areas which have a strong probability of being favorable for wind-generated energy.

Development in the County creates patterns of high energy use. The west and north coast heavy industry complex is predominantly in petroleum refining, chemicals, steel, woodfibre processing, and sugar and other food processing--precisely the most energy-intensive types of industry. The suburban community pattern, dominated by large single family dwellings set on large lots, is also reported to be a high energy-consuming development pattern as compared with the more dense metropolitin city, on a per capita basis, and also uses energy by dependence on auto transportation, higher energy costs for initial construction and long-term maintenance of roads and utility lines, public service vehicles (police, trash collection) and may have high energy costs for pumping water and sewage.

The most rapid development in the County in the residential, commercial and public works sectors has occurred during the last 25 years, precisely the period in which building design and construction, heating, cooling and ventilation systems, motors, and appliances have shown a distinct trend to energy inefficiency. Thus the age of buildings in the County contributes to high energy use.

Despite the factors noted above, there are many conservation opportunities which can substantially reduce energy consumption in individual buildings and could result in Countywide conservation of more energy than would be needed to provide for continued growth and development. All sectors would require efficiency standards in new buildings, accompanied by a serious retrofitting program. On a national basis, it is estimated that

up to 40 percent of industrial energy can be conserved, although 10 percent is more representative of the conservation potential with only a minimal investment. Aside from the hundreds of individual energy-using operations, each of which presents a conservation opportunity, the heat-recovery possibilities of on-site total energy systems, solar pre-heat of processing water, and on-site generated electricity appear to provide excellent feasibility for industrial areas.

Commercial and office buildings can conserve 35 percent or more of energy use through operations and maintenance. This is reported to be true throughout the nation, and has been amply illustrated by energy use reductions in County-owned buildings since 1972. For new non-residential buildings it is becoming apparent that first costs as well as long-term costs are lower for energy-conserving buildings, and that significant energy use reductions can be achieved by conventional means such as the State standards for non-residential buildings which will be mandatory in 1977.

New residential buildings can achieve more than the estimated 20% conservation under tate energy standards of 1975, particularly by addressing efficiencies in mechanical systems and appliances, and by more directly addressing energy used for summer space cooling. These further measures, with a conservation value of 37% over existing average use, if applied to new residences and to retrofitting 5 percent of existing residences each year, could conserve over 4 trillion BTUs a year after 15 years, equivalent to over 700,000 barrels of oil annually.

Although many regulations and economic incentives will come from the Federal and State governments, there are conservation programs which may be instituted by local government as well. A recent trend to discourage sprawl, enforced by local governments, is a primary means of avoiding establishing a land use distribution which will be inherently high in energy costs for initial construction and long-term operating, maintenance, and transportation. County administered and funded projects should also reflect the energy--and cost--savings of conservation. The project approval and Environmental Impact Report processes of the Planning Agency can ensure that full consideration of energy use is explored and made available for public discussion, and that appropriate conservation measures are incorporated into new projects by project design, landscaping and conservation in buildings.

III. ENERGY CONSUMPTION IN CONTRA COSTA COUNTY

A. PATTERNS IN ENERGY CONSUMPTION

Contra Costa County contains a mix of low density suburban cities and unincorporated communities, an agricultural district with 11,000 rural residential, and an energy-intensive heavy industrial complex on the west and north coasts. Although all income groups are represented in the County, the balance is toward high income households, particularly in the suburban communities of the unincorporated County and suburban cities which have experienced rapid growth in the last 20 years. Commercial buildings strongly tend to be single story structures surrounded by landscaping and parking lots. This type of development results in high energy consumption, in the following ways:

- Household income is strongly correlated with energy use (see Section IIIB, Determinants in Energy Consumption).

- Single family detached dwellings consume more energy than attached units or apartments.

- The suburban land use pattern results in very little public transportation and great reliance on the car.

- The commute pattern is strong, with from 20% to 80% of workers from various communities commuting out of the County each work day, primarily to Oakland and San Francisco.

- The suburban distribution of public facilities (schools, libraries, recreation facilities) increases reliance on the car and school buses.

- The low-density development pattern results in many miles of utility lines and roads, all requiring energy for construction and maintenance.

- Having more or less filled in the valley floors, development is now moving into the hills, an indication of higher energy use for construction and maintenance in these areas in the future.

- Heavy industry in the County consists of the most energy-intensive types; petroleum refining, petro-chemical products, fabricated metal products, wood fiber processing, and sugar and food processing.

- Most of the commercial centers in unincorporated communities, and the newer shopping centers throughout the County, were constructed in the last 20 years, a period of design which did not emphasize energy conservation.

- Irrigated agriculture in the County shares the national pattern of high energy use for equipment, chemicals and transportation.

These factors, set by past history and present trends, result in a high Countywide consumption of fossil fuel products and a high per-capita energy consumption for household and other personal uses.

B. DETERMINANTS IN ENERGY CONSUMPTION

Environmental, economic and institutional factors affect energy consumption on a Countywide basis and in individual buildings. This section discusses the key elements for each category and points to anticipated future changes which will have significant impacts on energy use in the near and long-term future.

1. Environmental Factors

a. Regional Climates

Contra Costa County is characterized by mild winters with occasional periods of fog or overcast persisting for more than three days. "Heating degree days", a measure of requirements for space heating, vary from 2,450 to 3,000, as compared with 5,800 heating degree days for Boston, Massachusetts and 7,500 for Truckee, California.

The situation is different regarding the need for summer air conditioning. "Cooling degree days", a measure of requirements for space cooling, vary from 0 to 1,100, reflecting significant climate differences between the cool west coast directly exposed to the Pacific westerlies, and the hot summer climate of the San Joaquin Valley to the east, with July and August temperatures frequently exceeding 100 degrees.

Table III-1 shows heating and cooling degree days in the County listed according to summer climate differences. See Glossary for detailed explanation of degree days.

The County's west and north coasts are subject to strong persistent westerly winds, as are the northwest-southeast trending high ridges of the Coast Range and Diablo Range which transect the County. Interior valleys are periodically ventilated by regional winds--approximately every fifth day in summer and fall--but are frequently characterized as having "light variable winds", indicating movements of the air mass in response to diurnal temperature variations. These winds do not add an appreciable winter chill factor which would increase heating needs, and are marginal to moderate in value for summer ventilation of buildings.

b. Microclimates

Because of the great topographic relief in the County, microclimates can vary considerably from the regional climate. Microclimate factors include:

1. Slope aspect. Southwest and west facing slopes experience more solar heat gain than northeast and east facing slopes. The impact of differing solar radiation is reflected in

Map III-1 HEATING DEGREE DAYS

Map III-2 COOLING DEGREE DAYS

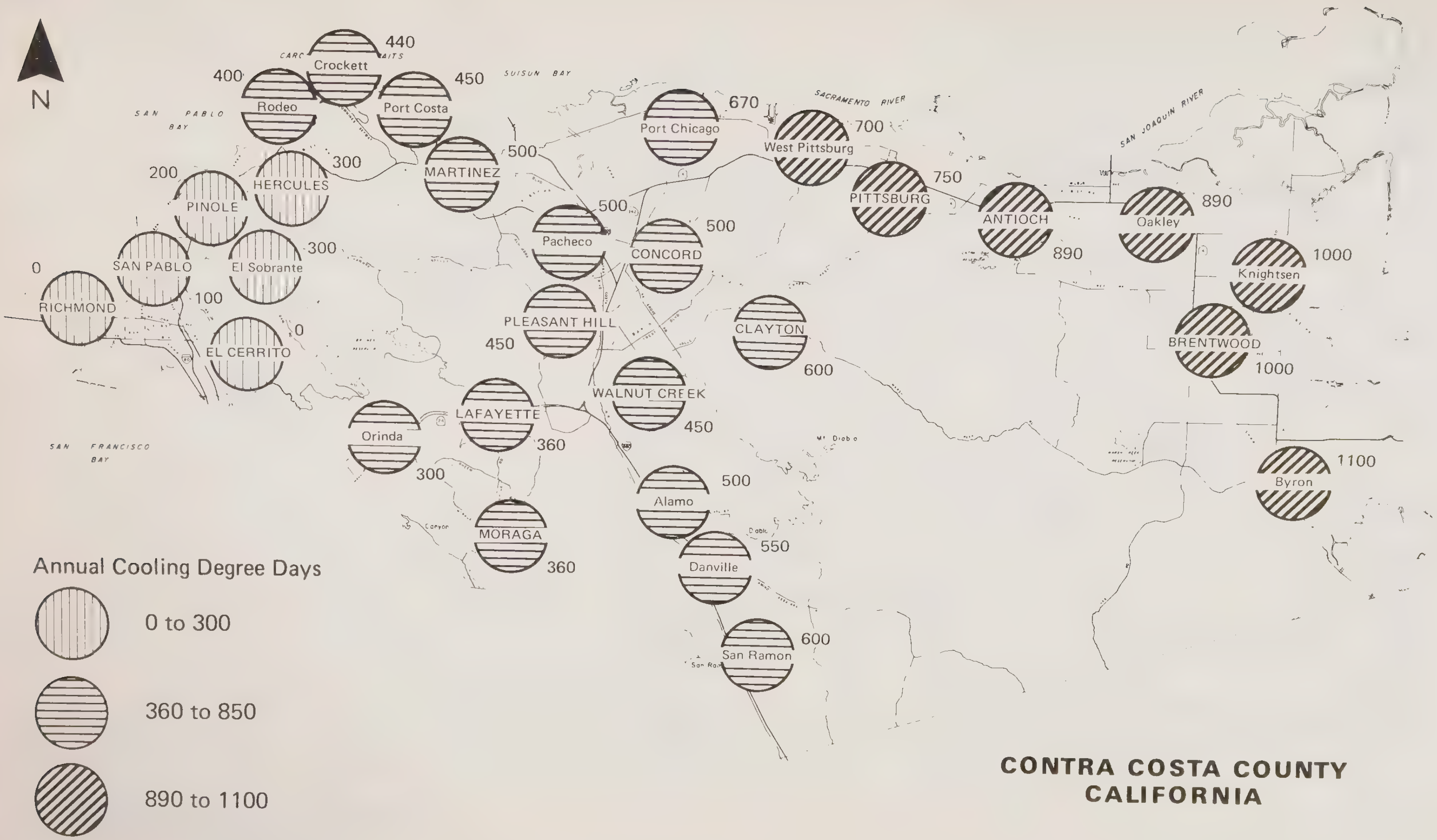


TABLE III-1: HEATING AND COOLING DEGREE DAYS

Climate Region	Community	Heating Degree Days	Cooling Degree Days
West Coast	El Cerrito	2900	0
	El Sobrante	2800	300
Marine Climate	Hercules	2750	300
	Pinole	2600	200
	Richmond	2550	0
	San Pablo	2600	100
North Coast	Crockett	2720	440
	Martinez	2500	500
Marine-Warm Summer	Port Chicago	2600	550
	Port Costa	2700	450
	Rodeo	2700	400
Central County	Alamo	2800	500
	Clayton	2700	600
Interior Valleys	Concord	2650	500
	Danville	2750	550
Colder & Warmer	Lafayette	3300	360
	Moraga	3300	360
	Orinda	3000	300
	Pacheco	2600	500
	Pleasant Hill	2800	450
	San Ramon	2700	600
	Walnut Creek	2800	450
East County and San Joaquin Valley Area	Antioch	2600	890
	Brentwood	2500	1000
	Byron	2450	1100
	Knightsen	2500	1000
Mild Winters	Oakley	2500	890
Hot Summers	Pittsburg	2650	750
	West Pittsburg	2600	700
Massachusetts	Boston	5800	
California	Truckee	7500	

Source: U. C. Berkeley, Energy Resources Group
Last two items: Energy, Environment and Building, by Philip Steadman, Cambridge University Press, 1975.

native vegetation types. Precipitation being equal, and woodlands occur on northeast and east facing slopes. Map 3 delineates areas where slopes are predominately facing southwest, west and northwest.

2. Wind exposure. Buildings located on slopes above the valley floor are subject to substantially greater winds than the "light variable" winds recorded near the ground at weather stations. In winter, wind-exposed buildings are subject to wind chill which increases heating needs, but which can contribute to natural ventilation in summer, thus reducing summer cooling needs.

3. Cold air drainage. Valley and canyon floors tend to be several degrees cooler at night during winter as the cold air sinks to low areas. These areas may also require more cooling in summer due to lack of wind.

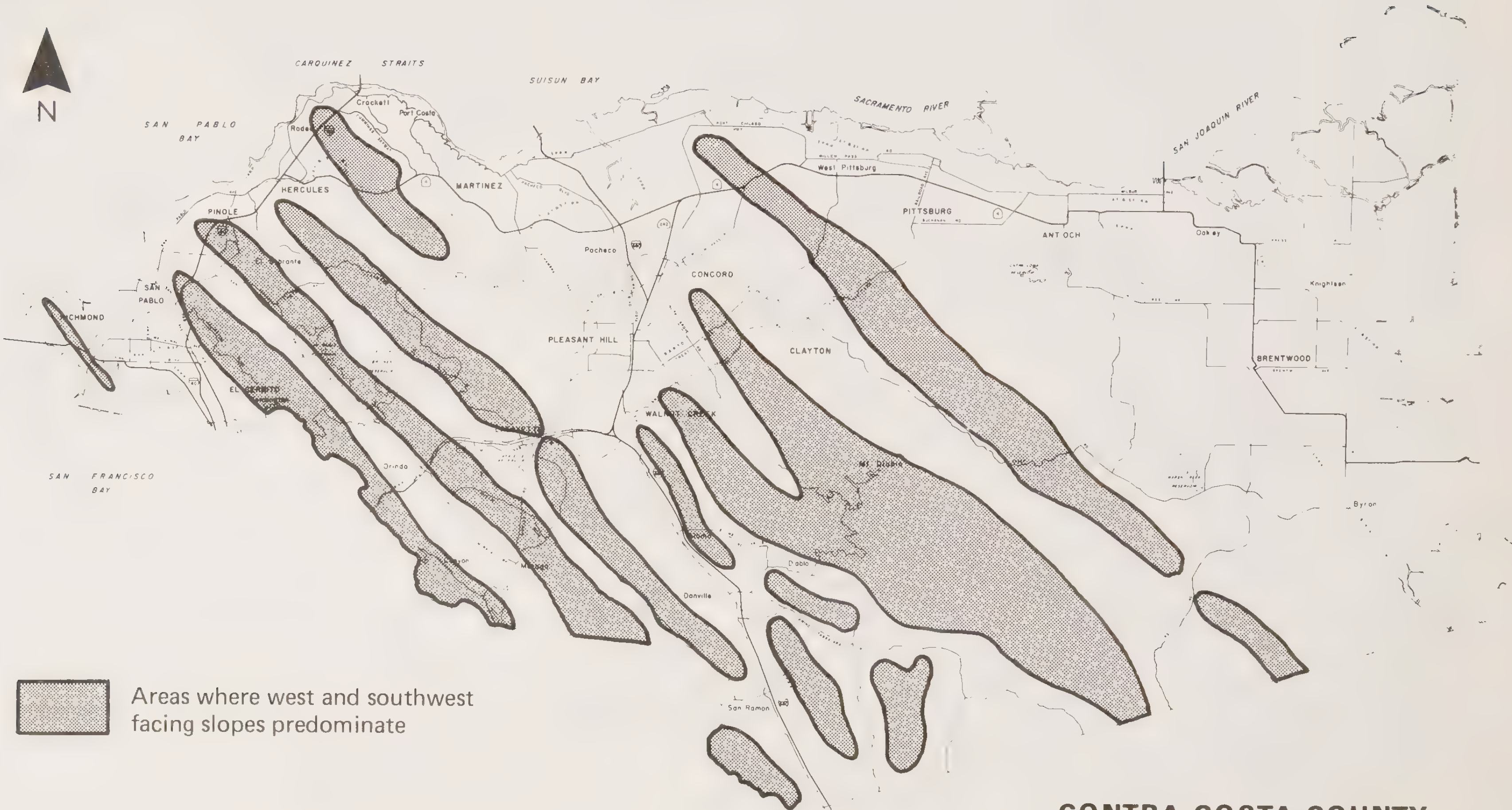
4. Areas above the inversion. On approximately two out of three days the Bay Area experiences a temperature inversion at an elevation between 1,500 and 3,000 feet. Warmer air lies above the inversion. Deer are observed to move uphill at night in winter in order to enjoy these warmer temperatures. Wind data above the inversion is lacking, but may be available from the Bay Area Air Pollution Control District in 1977. Personal observations indicate that strong persistent westerlies occur above the inversion. Mt. Diablo, at 3,849, is notably windy. Other high ridges display "wind barrens" on the crest, an indication of strong winds above the inversion.

5. Urban. Urbanization creates a hotter, drier, more desert-like climate. Paving, reflective surface, vehicles, and lack of vegetation raise local air temperatures and reduce humidity. Precise data are not available on the extent of this effect. As a rough figure, land conversion of 50 acres or more from agriculture to commercial and industrial uses could effectively lower winter heating degree days by 5 to 10 percent, and increase summer cooling degree days by 20 by 30 percent locally.

c. Heating and Cooling Needs

All climates in the County require winter heating. The coolest areas, around Lafayette, Moraga and Orinda, require approximately 25% more heating than warmer west and east County communities. Residences in cool summer areas with 0 to 300 cooling degree days usually do not have, or require, air conditioning. Residences in moderately hot summer areas, with 400 to 700 cooling degree days, can avoid air conditioning and maintain interior comfort levels provided that insulation and ventilation (particularly attic ventilation) are adequate, walls from 22 degrees west of north counterclockwise to 45 degrees east of south are shaded, and low heat-waste appliances are used. Residences in hot summer climate areas, with 800 to 1,100 cooling degree days, would require additional aids to avoid air conditioning, including a slab-on-grade floor and thermal mass walls such as insulated block or masonry.

Map III-3 GENERALIZED SLOPE ASPECT



Source: C.C.C.P.D.

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It was determined by the City of Davis in Yolo County, a climate regional similar to Brentwood, (1000 cooling degree days), that a single family, single story residence can be maintained with interior temperature of 75 degrees or less, with the exception a few days a year, without mechanical air conditioning.

Average annual total BTU's per person and per household are to strongly climate related, but for electricity alone, it is evident that air conditioning needs affect electricity consumption. Table III-2 relates electricity use to cooling degree days. The relatively higher use and less cooling degree days in Pinole and central County cities is related to income not climate. Lower income households in the east County are not as extensively supplied with air conditioning, thus the residential average use does not reveal the entire electricity required to achieve comfort in the east County climate.

Non-residential buildings have more varied characteristic in size, design and use than residential buildings, making it difficult to determine the energy relationships to climate. Lack of provisions for natural ventilation plus the heat load generated in non-residential buildings by lights, machines and high occupancy levels results in the use of air conditioning in institutional and commercial buildings during mild weather when residential buildings do not need cooling and when outdoor temperatures are comfortable.

Compared to continental climates, the County's climates are mild and require only moderate annual heating. Buildings in the central and east County warm-summer areas require provisions for space cooling for 2 to 4 months a year, July through August in the central County, and June through September from Antioch east and south through Byron.

2. Economic Factors

The cost of energy affects energy consumption Countywide and in individual buildings. The key to the present pattern of high and wasteful energy use is a 25-year period of cheap natural gas and electricity. All indications are that this period is over. As the relative cost of energy rises, consumption can be expected to be reduced. Predictions of future energy consumption for new development should be adjusted to reflect judgments about trends just now beginning. The economics of alternative sources and conservation measures are discussed in Section V, Economic Feasibility.

a. Residential Energy Use and Household Income

It is evident that household income and energy use are closely related. High income households also tend to have large average household size and strongly tend to live in newer, single family detached housing in the central County urban corridor. Table III-3 lists energy use and median income for the 15 incorporated cities for which PG&E made energy use data available, listed according to increasing use per person.

TABLE III-2: COOLING DEGREE DAYS AND RESIDENTIAL ELECTRICITY USES

Region	City	Cooling Degree Days	Annual Residential Electricity Use in KWH
West Coast	El Cerrito	0	4764
	Richmond	0	4461
	San Pablo	100	3785
	Pinole	200	6690
	Hercules	300	4820
North Coast	Martinez	500	5798
Central County	Lafayette	360	8057
	Moraga	360	9985
	Pleasant Hill	450	7895
	Walnut Creek	450	6778
	Concord	500	6419
	Clayton	600	9437
East County	Pittsburg	750	6059
	Antioch	890	6843
	Brentwood	1000	6047

SOURCE: U. C. Berkeley, Energy Resources Group. (Cooling Degree Days)
P G & E (KWH)

Note that there is a distinct correlation between income and energy use and also that energy use per person rises markedly in the upper income communities. This trend is less marked in Pinole, which does not require summer air conditioning.

Data is not available for energy use in the County's unincorporated communities. Estimates of energy use can be derived by comparing Table III-3 with Table III-4, income and household size for unincorporated communities.

Table III-3 and III-4 are not applicable to attached and apartment units, but as a rule of thumb, energy use and costs may be reduced 20% for attached units and 40% for apartments, based on estimates prepared by the U. C. B. Energy Resource Group and PG&E's studies of low-use customers. Alternate sources of energy for residential buildings, including solar energy, require separate evaluation. See Section VI, Economic Feasibility.

b. Economic Factors in Non-Residential Energy Use

As is true in residences, the availability of cheap abundant energy has led to wasteful consumption in non-residential uses. Since the mid-1950's, non-residential buildings have commonly been constructed without regard for energy costs. Industrial and agricultural operations have also reflected low-cost natural gas and electricity. It has been estimated (A Time to Choose, Ford Foundation, 1974) that 10% of industrial energy can be conserved with relatively little investment, and that 40% can be conserved at "reasonable" cost. Major industries on the County's west and north coasts--petroleun, chemicals, steel and wood fibre--are the most energy-intensive types of industries in the nation. Fourteen industries in the County use over 400,000 KWH of electricity a month. At a rate of $.018 per KWH, these industries have annual electricity bills in excess of $85,000, a cost which is expected to double by 1980.

High energy-using institutions, including hospitals and colleges, also have annual energy costs in the $80,000 to $500,000 range, depending on the size of the facility. It was found that a hospital at the Travis Air Force Base, in adjacent Solano County, could reduce its electricity cost 57% over the lifetime of the building by diesel generation on-site rather than by tying into the power company. (Conservation and Peak Power, UCB, 1975.) This may also prove to be the case for other large buildings with commercial, industrial and institutional uses.

3. Legal, Institutional and Market Factors

Public policy and regulations at all government levels affect the present energy consumption and will affect conservation in future. Virtually without exception, public policy, laws, regulation, and customs over the last 25 years, have encouraged a luxurious use of

TABLE III-3: AVERAGE ANNUAL RESIDENTIAL ENERGY CONSUMPTION AND HOUSEHOLD INCOME

Community	Annual Household BTUx1000	Average Household Size	Use per Person BTUx1000	Median Income Per Household In Dollars
El Cerrito	121,845	2.5	48,738	15,056
Richmond	122,012	2.7	45,190	10,353
San Pablo	105,507	2.5	42,203	9,332
Pinole	147,613	3.2	46,129	17,264
Hercules	113,136	2.4	47,140	14,333
Martinez	126,271	2.8	45,097	14,126
Lafayette	189,614	2.8	67,741	21,207
Moraga	300,649	3.2	93,953	25,935
Pleasant Hill	142,322	2.8	50,829	16,089
Walnut Creek	141,403	2.4	58,918	17,153
Concord	127,289	3.0	42,430	15,241
Clayton	177,585	3.6	49,329	21,756
Pittsburg	121,161	3.0	40,387	11,670
Antioch	117,435	2.9	40,495	13,175
Brentwood	117,220	2.0	40,421	9,778

TABLE III-4

AVERAGE HOUSEHOLD SIZE AND MEDIAN INCOME, UNINCORPORATED COMMUNITIES

COMMUNITY	AVERAGE HOUSEHOLD SIZE, 1975	MEDIAN HOUSEHOLD INCOME, 1975	CLIMATE REGION
North Richmond	2.6	$ 3,063	West
Canyon	2.4	4,833	Central
Knightsen	2.2	7,500	East
West Pittsburg	3.2	8,784	North West
Bethel Island	2.3	9,833	East
Oakley	3.0	10,280	East
Clyde	2.9	10,500	North West
Byron	2.9	10,799	East
Sand Hill	3.2	10,987	Central
Crockett	2.4	11,756	North West
Rodeo	2.9	12,281	North West
Vine Hill	2.9	12,502	Central
Pacheco	2.7	13,548	Central
El Sobrante	2.8	14,742	West
East Richmond Heights	2.8	14,758	West
Port Costa	2.9	15,863	North West
Montalvin/Tara Hills	3.5	15,988	West
Discovery Bay	2.5	19,642	East
Kensington	2.6	19,790	West
San Ramon	3.1	21,387	Central
Danville	3.3	22,768	Central
Alamo	3.3	24,123	Central
Diablo	3.6	25,690	Central
Orinda	3.1	27,078	Central
Total Unincorporated County	3.0	17,070	

SOURCE: 1975 Census, Contra Costa County Planning Department.

energy, either by subsidies and regulations or by their lack. The following list is not exhaustive, but indicates the range of legal and institutional factors and customs which have contributed to high energy consumption. Many of these are now in the process of revision in response to today's conservation needs.

- Federally subsidized hydroelectric
- Oil depletion allowance and other subsidies to oil companies
- Regulated natural gas prices
- Nuclear research (the promise of cheap, abundant electricity
- Gas and Electric supply company profit structure set by Public Utilities Commission (PUC)
- Lower rates for large energy consumers
- U.S. Department of Agriculture advice on chemical applications
- Inefficient building practices based on cheap energy (the glamour of glass walls)
- Lack of marketability of conservation features in residential and commercial buildings
- Emphasis on first cost rather than life-cycle costs
- Building codes
- Continually lowered efficiency of mechnical systems, appliances and small motors

The close association of energy use and economics is clear from the above examples. New legislation, programs, standards and marketing factors have appeared in the last few years which indicate the development of a different frame of reference: a social attitude of energy conservation and economics. They include:

- Federally subsidized research and development in alternative sources of energy and recycling.
- HUD residential energy standards and grants for solar residences
- Partial removal of oil subsidies.
- Possible de-regulation of national gas prices. Sharp cost rises reflecting energy as a commodity rather than a service.
- Inverted rate structure (PUC).
- "Lifeline" rate structure for residential users (PUC).
- Research in alternatives to high use of agricultural chemicals (U.S.D.A.).
- State energy conservation standards for building construction (ERCDC).
- Consumer demands. Presently interest is greater in the industrial, commercial, institutional and government sectors. Residential interest is growing as costs rise and through public education. Consumers ask to see EER tags on appliances.
- State and consumer interest in long-term operating and maintenance costs.
- State and local government subsidies, California's income tax credit for solar, local government reduced permit fees (Tiburon).

- Local government regulation. Building codes more stringent than State standards, (City of Davis), retrofit requirements on re-sale of homes (City of Livermore), Energy Elements in the General Plan, (City of Indio), project review procedures and Environment Impact Report review, solar zoning.
- Residential lenders consider utility costs in determining qualifications for a loan (Eastern U.S.).

4. Possible Future Determinants in Energy Use

In the next 2 to 10 years a number of changes in energy availability and energy use are expected. Environmental and economic needs will result in subsidies, policy, and regulation at all government levels to encourage conservation as well as develop new sources of gas and electricity. But there are compelling forces now becoming evident which strongly indicate that the main thrust in the future will be conservation, and that conservation will provide the largest "new" source of energy in the next decade.

a. Environmental Factors

As in the past, the combination of regulating constraints and economic incentives will work to implement national goals. Additionally, the adverse environmental impacts of developing new supplies may join with other factors to provide the impetus for conservation rather than energy development. Environmental impacts may include:

- Air pollution problems in Contra Costa County from burning oil for electricity generation by the power company and industry.
- Public pressures to avoid strip mining for coal or uranium ore.
- Slower growth in heavy industry due to unresolved air and water quality issues.
- Public safety issues regarding nuclear plants.
- Constraints on community development because of air and water quality problems.
- Rising energy costs--residential and commercial rates double by 1980 and again by the late 80's.
- Costs of non-depleting sources (solar, wind) become economically favorable.
- Costs of conservation are less than cost of continued investment in new supplies (true today, but not yet a well-developed concept)
- On-site power generation in industry, institutions, and large commercial developments (Total Energy Management).
- Mass scale wind and/or solar generating in Contra Costa County.

b. Legal, Institutional and Market Factors

Many of the following factors are being discussed by government agencies, are being urged by conservation proponents, and are evidenced in reports and speculative comments by energy experts. The time frame in which these concepts will reach fruition is not predicted, but if the future is conservation rather than new source oriented, the following suggestions have a strong probability of being part of the everyday future social system.

- Federal and State and local government subsidies for retrofit of existing buildings (limited availability now).
- Funds for Federally-assisted housing and other community development programs tied to energy conservation requirements.
- Conservation regulations regarding re-sale buildings.
- New projects require energy review (presently in effect, but not well-developed).
- PUC maintains "lifeline" rates for residential users. Special economic aid to poor.
- Community growth depends on community conservation--an "energy budget" for each jurisdiction.
- Power company retrofits power plants to reduce energy lost electricity generation.
- Financing more readily available for projects with significant conservation features and alternative sources of energy.
- Local government fees and property valuation reduced for solar devices.
- Consumer demands - greater marketability.
- Electrical space and water heating allowed only as back-up to solar.

C. PREDICTING RESIDENTIAL ENERGY USE

Because continued rapid residential development is expected in the unincorporated County, and because residential projects are subject to detailed project approval precedures by the Planning Agency, a key feature of this study is an analysis of the relationships among various socio-economic factors and energy consumption in order to identify the major factors in household energy use. From this, estimates of future residential energy use are derived, and also the energy-saving potential of conservation programs, discussed in Section V, Conservation Potential, and Section VI, Economic Feasibility.

Annual average use of natural gas and electricity by household for 1974 was provided by Pacific Gas and Electric Company for the 15 incorporated cities, and for the total unincorporated area of PG&E's East Bay Division, including Contra Costa and Alameda Counties. The amounts are based on residential meter readings and do not include the energy required to deliver gas and electricity to the residence. This is the basic residential energy use data used in this report.

Attached units and apartments use 30% to 50% respectively, less energy for space heating than detached dwellings. Other energy use is also somewhat lower because of smaller household size and fewer appliances. Exact average use for attached units and apartments is not known, but as a rule of thumb, an attached unit can be assumed to use 80% of the unincorporated average, and an apartment can be assumed to use 60%. These estimates are included in Table III-5. Estimates should be adjusted for varying locations. A large high income high energy use apartment in the Lafayette-Morage-Orinda area may be assumed to use virtually as much energy annually as the unincorporated average, while a more modest unit, without air conditioning or dishwasher, would be significantly lower in energy use.

TABLE III-5

AVERAGE ANNUAL RESIDENTIAL ENERGY USE, 1974

Community	Electricity in KWH	Electricity in BTU's x 1000	Natural Gas in Therms	Gas in BTU's x 1000	Total BTU's x 1000
Richmond	4,461	15,212	1,086	108,600	123,812
San Pablo	3,785	12,907	926	92,600	105,507
Pinole	6,690	22,813	1,248	124,800	147,613
El Cerrito	4,764	16,245	1,056	105,600	121,845
Martinez	5,798	19,771	1,065	106,500	126,271
Moraga	9,985	34,049	2,666	266,600	300,649
Lafayette	8,057	27,474	1,622	162,200	189,674
Walnut Creek	6,778	23,113	1,184	118,400	141,513
Pleasant Hill	7,895	23,922	1,154	115,400	139,322
Concord	6,419	21,889	1,054	105,400	127,289
Clayton	9,937	33,885	1,437	143,700	177,585
Pittsburg	6,059	20,662	1,005	100,500	121,161
Antioch	6,843	23,335	941	94,100	117,435
Brentwood	6,047	20,620	966	96,600	117,220
Unincorporated East Bay Division	6,733	22,960	1,268	126,800	149,760
Attached unit 80% of Detached Unit	5,386	18,366	1,014	101,400	119,766
Apartment 60% of Detached Unit	4,040	13,776	760	76,000	89,776

SOURCE: PG&E. For attached and apartment units, Contra Costa County Planning Department, based on estimates provided by UC Berkeley Energy Resources Group.

Table III-6 delineates the energy use, climate and socio-economic factors used in this analysis. Energy use is from PG&E's average residential energy use data for 1974, climate data was provided by the U.C. Berkeley Energy Resources Group and other factors are taken from the County's 1975 Census.

Alternately using kilowatt-hours (KWH) of electricity and therms of natural gas as the dependent variable, a multiple regression was run using the remaining several characteristics as the independent variables resulting in the correlation matrix, Table III-7. The method is described in Appendix B.

The matrix shows that median income and average number of bedrooms are highly correlated with both gas and electricity use, and numbers of persons per household is highly correlated with electricity use. This establishes the socio-economic pattern of high income, large home, and large family size--the high energy use household.

Looking at the correlation matrix, the strongest correlations are between income and median number of rooms, a measure of building size, and income and gas use, indicating that most space heating systems are fueled by natural gas. The correlation between income and electricity use implies a large number of energy-inefficient appliances and a larger percent of units provided with electric air conditioning. This agrees with observations that new, single family detached residences in the unincorporated County tend to have optional air conditioning, large appliances, and many convenience outlets for gadgets. In many major subdivisions, electric trash compacters are standard equipment. Since these luxury mass housing developments are a relatively recent phenomenon, with the highest electricity using communities having average ages of structures from 8.9 to 19.9 years (Table III-6), the correlation between electricity use and age of structure reinforces observations on the probable high electricity use in new residential developments as compared with older neighborhoods.

Given the limitations of generalized information, the regression analyses do indicate an order of magnitude relationship between socio-economic factors and energy consumption, and, despite the generalized nature of the results, the energy use pattern expressed in the correlations is in agreement with County population studies which identify certain areas of the County as characterized by larger than average high income families occupying large single family detached dwelling units, with many energy-inefficient gadgets, plus central heating and cooling.

Future residential development in the unincorporated County is expected to provide for this high energy-use household, based on approved projects and market conditions in the rapidly developing central County corridor, plus lesser amounts of similar high-use rural-residential development in east County and west County. For the San Ramon Valley area, the major central County focus for development, an average household size of 3.2 persons is projected to 1990, 0.3 persons per household greater than the County average for 1975, and equal to high income, high energy-using Moraga. New single family homes in this market have a selling price range of $65,000 to $120,000, and more, in 1976. Thus, the projected housing for

TABLE III-6: RESIDENTIAL ENERGY USE AND RELATED FACTORS

	Residential Energy Use		Climate Factors		Socioeconomic Factors				
Community	KWH	Therms	Heating Degree Days	Cooling Degree Days	Median Income	Average Household Size	% Single Family Dwelling Units	Average Number Bedrooms	Median Home Age
El Cerrito	4764	1056	2900	0	15,056	2.5	75.8	2.6	24.6
Hercules	4820	967	2750	300	14,333	2.4	84.3	2.8	58.0
Pinole	6690	1248	2600	200	17,264	3.2	83.0	3.0	15.4
Richmond	4461	1086	2550	0	10,353	2.7	67.1	2.4	26.8
San Pablo	3785	926	2600	100	9,332	2.5	52.6	2.1	21.0
Martinez	5798	1065	2500	500	14,126	2.8	72.9	2.7	16.8
Clayton	9937	1437	2700	600	21,756	3.6	95.4	3.5	10.1
Concord	6419	1054	2650	550	15,241	3.0	65.4	2.7	13.3
Lafayette	8057	1622	3300	360	21,207	2.8	77.4	2.9	19.9
Moraga	9985	2666	3300	360	25,935	3.2	71.1	3.4	8.9
Pleasant Hill	7895	1154	2800	450	16,089	2.8	73.5	2.7	17.9
Walnut Creek	6778	1184	2800	450	17,153	2.4	43.1	2.5	9.5
Pittsburg	6059	1005	2650	750	11,670	3.0	78.4	2.7	18.8
Antioch	6843	941	2600	890	13,175	2.9	74.4	2.7	11.0
Brentwood	6047	966	2500	1000	9.778	2.9	65.3	2.5	12.3
Unincorporated East Bay Division	6733	1268	N/A	N/A	11,393*	3.0*	71.1*	2.9*	16.2*

*Unincorporated Contra Costa County.

TABLE III-7

RESIDENTIAL ENERGY CONSUMPTION: RELATED FACTORS:
CORRELATION MATRIX

	Heating Degree Days H-D	Cooling Degree Days C-D	Average Age of Structure A-A	Percent Single Fam. House SF/H	Persons Per Household P-HH	Median Household Income M-I	Median Number of Rooms M-R	Average Annual Kilowatts KWHRS	Average Annual Nat. Gas N-G
H-D	1.00								
C-D	0.24	1.00							
A-A	-0.15	-0.42*	1.00						
SF/H	0.09	0.08	0.15	1.00					
P-HH	0.04	0.38*	0.55***	0.58***	1.00				
M-I	0.78***	-0.08	-0.44*	0.34*	0.48**	1.00			
M-R	0.60***	-0.02	-0.35*	0.52**	0.51**	0.92***	1.00		
KWHRS	0.46**	0.38*	-0.68***	0.42*	0.76***	0.83***	0.80***	1.00	
N-G	0.81***	-0.01	-0.47**	0.25	0.53**	0.94***	0.79***	--	1.00

*Indicates $p < 0.1$
**Indicates $p < 0.01$
***Indicates $p < 0.001$

SOURCES: U. S. Bureau of the Census, 1970 Census; 1975 Special Countywide Census of Contra Costa County; Pacific Gas and Electric Company.

at least the next 10 years will be in the larger 3 to 5 bedroom category and will tend to the upper range in energy consumption. Using a weighted average of the Clayton and Moraga figures for single family dwellings and the unincorporated figure for attached units and apartments from Table III-5, projected energy use is displayed in Table III-8.

Since the present and projected use figures are based on energy use in buildings constructed prior to the institution of the state energy conservation standards of 1975, they are high for post-1975 construction. As a guide to estimating consumption in new residential projects, Item 1 in Table III-8 is given for comparison. The conservation estimate on which Items 2 and 3 are based are discussed in Section IV, Conservation Potential. Figures for attached units and apartments are usable for the year 1975-1977. Post-1977 development of attached units and apartments may be reduced by 20% to reflect more efficient mechanical systems, appliances and lighting expected to be required by 1977.

TABLE III-8: PROJECTED RESIDENTIAL ENERGY USE

	Dwelling Unit Type	Electricity KWH	Electricity in BTU's x 1000	Natural Gas in Therms	Natural Gas in BTU's x 1000	Total BTU's x 1000
1.	Single Family Detached (pre-1975)	9975	30,014	2530	253,000	287,000
2.	Single Family Detached (1975-1977)	9900	33,800	2100	205,000	238,800
3.	Single Family Detached (post-1977)	7575	25,800	1550	155,000	180,800
4.	Attached (80% of Unincorporated average)	5386	18,368	1014	101,400	119,808
5.	Apartment (60% of Unincorporated average)	5050	13,800	760	76,000	89,800

IV. ALTERNATIVE SOURCES OF ENERGY

A. SUPPLY FORECASTS AND ENERGETICS

PG&E provides energy to Contra Costa County from domestic natural gas and electricity produced in steam generating plants which burn oil as fuel almost exclusively (1976). Hydroelectric is brought in from other parts of the State and, during the peak load season, from Oregon. Forecasts of future supplies of natural gas and imported low sulfur oil differ. Canadian gas will relieve shortages here when domestic contracts run out, but Canadian contracts may be short-term as Canadian national policy becomes more restrictive on exports of natural resources. The gas industry position is that price de-regulation would lead to discovery of additional domestic reserves. Although imported oil may remain in plentiful supply, it is subject to the vagaries of international politics, and it is U.S. policy to reduce reliance on this supply. Geothermal resources in the Bay Area are under development and are expected to supply 10% of electricity to PG&E's service area by 1990. Additional nuclear plants may be operational by that time. Coal gassification and shale oil recovery are possibilities in the longer run future.

Another "alternative source" is the conventional energy made available by conservation in existing uses. A steam generating plant, for example, that is designed to be 50% more efficient than today's average plant would double the BTU output from the plant. Although sources differ on forecasts of future supplies, virtually all sources emphasize the need for conservation, either to relieve short and long-term shortages, or because of economic and environmental considerations.

The new field of energetics, or analysis of all energy inputs required to provide net energy output, first developed by Howard T. Odum to reveal energy flows in nature, when applied to fossil and other national energy resources, reveals a situation of diminishing returns. Dr. Odum believes that "....many of our proposed alternative energy sources take more energy feed-back than present processes". (<u>"Energy Ecology and Economics"</u>, by Howard T. Odum <u>in</u> <u>Energetics</u>, Royal Swedish Academy of Sciences, 1972)

From this point of view, the net energy to do work which would be made available by exploitation of low quality earth resources will be marginal, and will be costly both economically and environmentally.

Net energy availability has been estimated by Herendean & Bullard, in <u>Energy Cost of Commerce Goods</u>, <u>1963 & 1967</u>, which states that it takes more than one BTU of energy input to produce one BTU of energy from coal, petroleum products, natural gas, and electric power, with the least favorable ratio for fuel-generated electricity. PG&E uses a figure of 3.226 BTU of energy input required to deliver 1.0 BTU of electricity to the user. (See Table VIII-2.) Exploitation of low-grade ores or remote fossil supplies is believed to require more and more energy input to make the latent energy in these sources available to do work. Thus we can see today's "energy crisis" as a problem in

limited non-renewable planetary resources with signifcant long-range implications for society and for future energy costs. On the other hand, a recent ERDA study prepared by Lockheed-California with several California and Oregon utilities, indicates that a large-scale wind turbine would generate 45 times the energy expended for the system during its 30-year lifetime. That is, one BTU input would yield 45 BTU's of usable energy. Although energentics information for passive solar energy collecting systems is not available, it appears probable that the net energy ratio from such systems would be even more favorable, since the lifetimes of solar collectors can be 20 years and more and there are no moving parts to maintain or replace.

B. ALTERNATIVE SOURCES IN CONTRA COSTA COUNTY

1. Mineral and Waste Resources

There are producing oil and natural gas fields in the County along the northwest coast and in the east County. These are owned by industries who use the products. Low-grade coal deposits in the Diablo Range have long since been mined out. One potential geothermal area, east of Byron, has been given a preliminary evaluation by the U. S. Geological Survey which determined that, based on an analysis of the water chemistry, the area may be developed for small amounts of steam electricity which could be used locally, but there is no potential for a large-scale geothermal plant.

No information is available on the potential for deriving energy from temperature gradients or the kinetic energy of the County's 70 square miles of off-shore waters.

PG&E has done some experimental work using agricultural wastes as steam generator fuel. An energetics analysis would reveal how to utilize the most energy output from agricultural wastes -- by soil improvements, composting for methane gas, or burning in steam-generating plants.

2. Waste Recovery

Anaerobic digestion of sewage wastes, agricultural wastes (particularly from feedlots), and organic solid waste materials, for the production of methane gas has been proven practical at the level of the homestead and the municipality. A recent Bay Area experiment is being undertaken jointly by PG&E, the City of Mountain View, and the Environmental Protection Agency to recover methane gas from the Mountain View solid waste site. It is expected that 600,000 cubic feet a day of processed gas will be recovered. This is sufficient to provide the gas used by 45,700 residences of the higher-than-average consumption pattern found in unincorporated Contra Costa County, or 15% of the existing residential housing stock.

The Contra Costa County Sanitation District has recovered and used methane from sewage for 20 years. The planned new treatment facility will include combustion of solid waste and sewage sludge for steam generation of electricity sufficient to run the plant. The City of Seattle plans to recycle trash and garbage into marketable industrial ammonia. Methanol, a high quality fuel which can be used in vehicles as well as in buildings, is produced by processes similar to ammonia production. The Combustion Power Company, a Menlo Park firm, has developed a solid waste fueled power plant which generates 1000 kilowatts of electricity from 100 tons of garbage a day. This scale of energy recovery is suited to smaller communities or to provide power for municipal facilities.

3. Solar Resources

All parts of the County are favorable for the utilization of solar energy for space heating and cooling, and water heating. Table IV-1 gives annual shunshine hours plus heating and cooling degree days, which are indications of space heating and cooling needs in the several county climate regions.

The Weather Factor column is an indicator of relative favorability for solar space heating applications. It is based on a comparative index developed by G.O.G. Lӧf (The Use of Solar Energy for Space Heating, General Report; United Nations: Rome, 1961).

The Weather Factor figure, representing an approximate ratio of solar radiation to heating needs is useful when solar radiation data is available in langleys per day for a particular location for January. The method is as follows:

1. January radiation in langleys per day on a horizontal surface is multiplied by 3.69 to give BTUs per square foot.

2. BTUs per square foot is multiplied by 1.5, the approximate ratio of solar radiation during the heating season to January radiation.

3. Multiply the resulting total by 200 for the number of days in the heating season, or by a more accurate number if known. The figure thus obtained represents an estimate of the total quantity of solar radiation received during the heating season, expressed in BTUs per square foot.

4. Total radiation obtained in Step 3 is then divided by heating degree days per year for the given location in order to yield the "weather factor". The higher the weather factor, the greater the percent of heating needs which can be provided by solar energy.

For Contra Costa County, there are approximately 200 langleys per day on a horizontal surface on December 21 (estimated from S. S. Fisher, Climate Atlas of the United States).

TABLE IV-1: SOLAR POTENTIAL

Location	Community	Sunshine Hrs./Yr.	Heating Degree Days	Weather Factor	Cooling Degree Days
West Coast	El Cerrito	2600	2900	76.34	0
	El Sobrante	2650	2800	79.07	300
	Hercules	2600	2750	80.51	300
	Pinole	2600	2600	85.15	200
	Richmond	2600	2550	86.82	0
	San Pablo	2600	2600	85.15	100
North Coast	Crockett	2750	2720	81.00	440
	Martinez	2750	2500	88.56	500
	Port Chicago	2750	2600	85.15	670
	Port Costa	2650	2700	82.00	450
	Rodeo	2600	2700	82.00	400
Central County	Alamo	2800	2800	79.07	500
	Clayton	2800	2700	82.00	600
	Concord	2750	2650	83.55	500
	Danville	2800	2750	80.51	550
	Lafayette	2750	3300	67.09	360
	Moraga	2750	3300	67.09	360
	Orinda	2750	3000	73.80	300
	Pacheco	2750	2600	85.15	500
	Pleasant Hill	2750	2800	79.07	450
	San Ramon	2800	2700	82.00	600
	Walnut Creek	2800	2800	79.07	450
East County	Antioch	2800	2600	85.15	890
	Brentwood	2850	2500	88.56	1000
	Byron	2900	2450	90.37	1100
	Knightsen	2850	2500	88.56	1000
	Oakley	2800	2500	88.56	890
	Pittsburg	2750	2650	83.55	750
	West Pittsburg	2750	2600	85.15	700
Mass.	Boston	2650	5800	25.88	
Calif.	Truckee		7500	25.83	

1. $200 \times 3.69 = 738$ BTUs/ft^2

2. X 1.05 = 1107

3. X 200 = 221,400 total BTUs/ft^2 during the heating season

4. Divided by the heating degree days as listed in Table IV-1, yields weather factors in the County from 67.09 to 90.37.

This is given as an indication of solar favorability throughout the County and is not refined to an extent that precise designs of solar collectors may be based on these figures. Since solar space heating is used in Boston, with a weather factor of less than 30, the weather factor is, for most of the country, an indicator of the required size of the system rather than an indicator of actual feasibility. Because the entire County is highly favorable for solar space heating, the key to favorability differences within the several climate regions of the County lies in the probability of extended periods of fog or overcast, a condition which would require the use of a fueled back-up heating system, and thus reduce the percent of space heating which can be provided by solar energy. Precise data is not available on the frequency of fog or overcast enduring for 4 consecutive days or more. However, the east County is subject to persistent winter ground fog, a characteristic of the San Joaquin Valley, and can be expected to experience one or more such periods during any given heating season. Other parts of the County are less subject to persistent ground fog, but may experience one or more extended periods of overcast during a season of higher-than-average rainfall.

Water heating is required all year, so annual hours of sunshine are given as an indicator of solar resources for this use. The entire County is favorable for solar water heating, but fog or overcast conditions during the winter would also affect the need to utilize a fueled back-up water heater during such periods.

The varying cooling degree days, a measure of cumulative seasonal needs for space cooling, indicate marked differences in summer temperatures and the duration of hot weather in different regions of the County. For all regions, summer sunshine is abundant and highly favorable for space cooling by evaporation or radiation. In the West Coast climate, 0 to 300 cooling degree days a year, mechanical space cooling is not required in naturally ventilated buildings, with the possible exception of buildings which have heat-generating industrial operations. In the North Coast climate, with 400 to 500 cooling degree days, air conditioning may be desirable for one to two months for sensitive populations such as infants and the ill, and in buildings which are designed to permit heat gain through glazing but not to permit adequate natural ventilation. The North Coast is subject to strong persistent westerlies, and thus is well situated for advantageous use of natural ventilation. This region is subject to brief period of hot weather, however, as are the cooler communities in the central County region.

The Central County region, where there are 500 to 600 cooling degree days, requires measures to achieve interior comfort for approximately 1 to 2 months. Mechanical air conditioning is not required in residences providing that design and construction prevent excessive heat gain. The east County, with 700 to 1100 cooling degree days, requires

mechanical air conditioning in most existing residential buildings in order to maintain July and August interior temperatures below 80 degrees. Well-constructed, well-insulated and well-shaded buildings can remain below 80 degrees except for a few days a year.

Favorability for direct conversion of solar radiation to electricity is related to total annual sunshine hours. All parts of the County are favorable for these applications, particularly during the dry season in late spring, summer and fall. Coastal areas, subject to night and morning overcast even in summer, are somewhat less favorable, as reflected in slightly fewer annual sunshine hours.

4. Wind Resources

Wind recording instruments are commonly located near the ground, not aloft, so there is little information currently available upon which to estimate the wind energy potential in the County. The Bay Area Air Pollution Control District expects to have data for winds above the inversion by 1977. Nevertheless, there are some indications of good wind potential. As noted in Section I, Climate Factors, winds near the ground in the urbanized valleys of the County are not of a strong persistent nature which is needed for efficient wind energy applications. West and North Coast winds, and winds aloft, particularly above the temperature inversion, are, or probably are, of a nature well-suited to wind-powered electrical generators. Prevailing strong westerlies and other seasonally dominant winds are known to continue above the inversion, but little precise information exists which would be useful for locating wind power mills. As a rule winds are stronger at a distance above the earth. This characteristic makes ridge tops ideal for power mills. The high ridge tops of the Altamont region, a few miles south of Contra Costa, have been identified by the Lawrence Livermore Radiation Laboratory (An Analysis of the Winds of Site 300 as a Source of Power. AEC Contract No. W-7405-Eng.48, 1973), as having strong and persistent winds ideal for power mills. The prospects of locating similar favorable sites in this County are good. There are sparsely vegetated ridge-top "wind barrens" in the southwest County -- Las Trampas and Rocky Ridge regions -- indicating strong persistent winds in these areas.

A prelimiary look at the County's potential for power mills indicates many areas worth investigating (Wind Generated Electricity, Map IV-1). Most experts in the field recommend wind measurements over several years for site evaluation A few advocates feel that the importance of an excellent site has been overestimated; that if tower heights are sufficient, good wind will be found, and that the mass production of power mills put into operation in a short time is a more economical approach for a large system as a whole. The latter approach could well prove true for a large scale program here, given the generally strong persistent winds reported on the dominant ridges and on lower western and northern hills receiving Pacific winds directly through the Golden Gate.

Site evaluation is more like prospecting for minerals than surveying. Variations of 20% between localities a few meters apart are common. Since power output is related to the cube of wind velocity, a 20% difference between two sites could result in a 70% difference in power generated. On a national survey basis, the Pacific Coast states are

Map IV-1 WIND POTENTIAL AREAS

Source: C.C.C.P.D.

CONTRA COSTA COUNTY
CALIFORNIA

considered less favorable than the central plains. However, topographic relief increases wind velocity on windward slopes and on ridge tops. There are several regions of the County which are regularly sugject to persistent higher-than-average winds because of the northwest-southeast trending ranges which cross the County. The highest wind-swept ridges are not populated, so installation of power mills would not interfere more than minimally with existing uses as rangeland, natural park, and watershed management.

Wind is an intermittent energy source. Uses which require a steady output of power also require a storage or backup system. Electrochemical storage batteries are not practical for large-scale applications, but fly wheels or electrolyzed hydrogen may prove suitable. In any storage system, or transfer of energy from one form or state to another, from 24% to over 50% of the energy is consumed. Therefore direct utilization is the most efficient, but this requires an interruptible load; a use which can operate when the wind blows and stop when winds are light. Feeding wind-generated power into the existing power grid is an example of an interruptible use, although it does require conversion of wind-generated electricity from direct current to alternating current in phase with the existing system.

Wind Mechanical Energy

The Dutch sail-type windmill for pumping water and grinding grain and the American multi-vane fan windmill for pumping water are the best known examples of utilizing wind's kinetic energy for mechanical work. The American multi-vane fan mill is used in remote areas in many parts of the world as well as being a typical feature of U. S. farms. The potential for expanding the use of wind energy to pump is great, partly because so many activities require pumping of water or other substances, and partly because pumping is often an interruptible activity. For example, water pumped into a storage reservoir can be released at a steady rate even though the pumping itself only takes place where the wind blows. This application of wind energy is not suited to small-scale urban areas which are presently served by a municipal water supply, but may be highly favorable for larger scale applications by a water agency for pumping to reservoirs and canals, sewage aeration, and industrial pumping of many types of liquid and gaseous materials which are lifted to storage tanks for later gravity or pressure flow discharges.

V. CONSERVATION POTENTIAL

This Section considers two aspects of conservation: conservation in buildings and conservation Countywide. Countywide conservation includes the long-term impacts of conservation in buildings, plus conservation opportunities in public utilities and public facilities and services. The predictions below come from PG&E energy growth estimates as presented in 'Addendum to Alternate Forecast, Second Edition', prepared for the State Energy Resources Conservation and Development Commission (ERCDC) in April, 1976. For residential buildings, PG&E data plus the County staff observations on local housing trends are used. For non-residential buildings and facilities, information was made available by the facility management. Growth projections for the County are from the 1975 County-wide census.

A. PREDICTING ELECTRICITY USE

Growth in electricity use has been rising over the last 15 years for all sectors, and for individual, residential and commercial buildings. Increases in commercial use per square foot of floor is reported to be due to ever higher lighting levels, oversized and inefficient heating, ventilation and air conditioning (HVAC) systems, increased glazing, and a general lack of need to design and engineer buildings for energy efficiency. The situation for industry in the County is not known, but some national reports indicate a growing inefficiency in electricity use in many industrial operations, while other reports point out areas in which greater electricity efficiencies have occurred prior to the stimulus of the national conservation effort. Agricultural use of electricity is not projected to increase or decrease significantly.

TABLE V-1: ESTIMATED ANNUAL ELECTRICAL USE GROWTH RATES
PG&E SERVICE AREA

SECTOR	YEAR PERCENT INCREASE			
	1975-78	1978-81	1981-85	Average, 1975-85
Residential	6.9	6.7	6.6	6.7
Commercial	6.3	6.0	5.9	6.1
Industrial	8.1	3.9	3.8	5.1
Chemicals	20.6	1.8	1.6	7.0
Agriculture	-1.3	0.0	0.0	0.0
TOTAL				6.2

Source: PG&E, 1976

Average electricity sales to residential customers increased approximately 60 percent per household between 1961 and 1975. This implies a widening ownership of air conditioning and electrical equipment and appliances, as could be expected in a period of increasing income, and also implies that newer residential units have built-in energy consuming characteristics and features to a greater degree than older structures. This agrees with the correlations for energy, use, and age of structures, (See Section III), and is apparently true throughout the PG&E service area. Based on past trends, it is predicted that residential electricity use will rise from an average of 6498 KWH in 1975 to 9467 KWH in 1985, in close agreement with County projection of 9975 KWH for larger than average single family detached dwellings, in the absence of conservation (see Table III-5). PG&E projections evidently assume continuing (at least to 1985) characteristics of inefficient electricity use, low efficiency HVAC systems, and appliances, and no market saturation for appliances and gadgets. This is a "business as usual" forecast in line with the statement in PG&E's The Outlook 1975, which states what a home which is insulated and weatherstripped is, "as well prepared as possible" for the years ahead. Assumptions stated in the alternate forecast include:

- high growth projections in all sectors

- economic recovery

- electric price increases in the long-run future at a rate not exceeding that of the rate of inflation (assumes no future oil cost rise like that experienced in 1974, and apparently no cost rises related to new, more expensive facilities, such as nuclear plants).

- conservation measures will gradually slow the electric energy consumption growth rate

- total energy demand will shift to electricity from other sources (notably from natural gas)

Electricity growth in the commercial sector is estimated to remain very close to a 6% per year increase through 1985. Agricultural electricity use varies from year to year, but is not expected to show an increase or decline trend. Peak load demand during the summer shows a decline in average growth rate from about 5.8 percent per year in the late 1970's to about 5.2 percent in the early 1980's. Summer peak demand growth rates have not been affected by energy conservation efforts as much as overall demand.

Another recent prediction, California's Energy Outlook, prepared for the California Council for Environmental and Economic Balance, 1975, estimates the average growth rate in electricity use in the State to be 4.2% for the period 1973-1985 and 3.2% for the period 1985-2000. The report states, "Therefore, even at zero energy growth (which represents an unrealistic amount of conservation)...the U. S. supply of oil and natural gas cannot meet this century's domestic requirements." (Underlining added) This report also states that a high degree of conservation is not included in the projections, with solar heating and cooling projected to increase at an average rate of less than 1% for the period 1973-1985 and a significant 18% for the period 1985-2000. Projections evidently do not include conservation through energy efficiencies in buildings and industrial operations, such as are or may be required by federal, state, or local governments.

B. PREDICTING GAS USE

Predictions of natural gas use are less well defined for this immediate area. National level reports, such as "The Energy Crisis & Gas Appliances" in The Energy Crisis, Selected Reports & Statements, Southern California Gas Company, circa 1974, projects 1990 demand at 48 trillion cubic feet, and supply at 27 trillion cubic feet. Of this, an unspecified but relatively small percentage is attributable to residential use despite the greater rate of increase in gas use by the residential sector in the period 1945-1970.

The reports predicting a shift from gas to electricity imply gas shortages a situation which cannot be relieved by the variety of means available, or potentially available, for electricity generation. Substitutes may be derived from wastes or from imported liquefied natural gas.

In Contra Costa County, industry and generating plants are now shifting to oil in order to avoid possible shutdowns when all available gas is allocated to high priority uses, primarily residences. Thus overall gas use is predicted to fall for the industrial and electric utility sectors, but will rise for residential, commercial, public, and institutional uses unless conservation in new buildings is accompanied by retrofitting existing buildings.

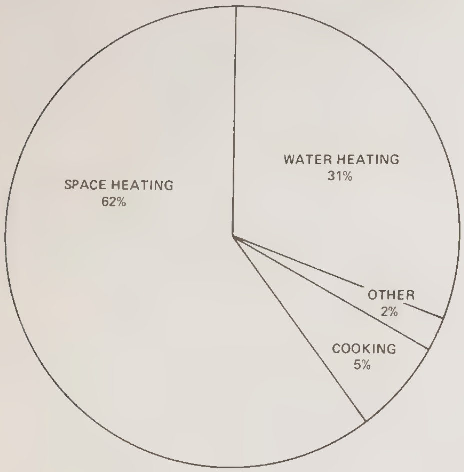
As with electricity, projections appear to be based on growth during a period of rapid expansion and cheap energy, and do not reflect either potential conservation or the "energy crisis" ethic.

C. RESIDENTIAL CONSERVATION POTENTIAL - INDIVIDUAL BUILDINGS

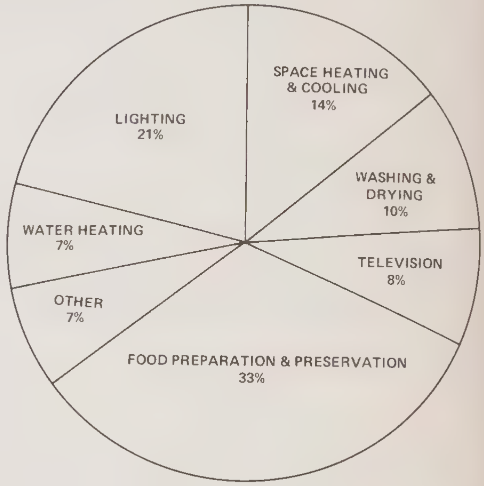
In order to examine the conservation potential in Contra Costa County, alternative conservation options were projected for new residential development and retrofit of existing residences. Estimates of conservation for both natural gas and electricity are included.

The conservation alternatives used in this analysis include a "no conservation" alternative for purposes of comparison, plus alternatives based on State energy standards of 1975, anticipated additional requirements for post-1977 construction, solar water heating, and "going solar" for water heating plus space heating. The impacts of these alternatives are based on an estimated conservation in the several uses of energy, delineated in Table V-2. Conservation estimates are approximate, but are within the range of estimates found in various reports, including pamphlets prepared by PG&E. Conservation values range from 20% for Alternative B to 77% for the "solar home". The assumptions for the energy use impact of each conservation measure are based on the evaluations found in several general sources and represent a preliminary assessment of the conservation value of the various features. The economics of the alternatives are explored in Section VI.

Table V-2 ESTIMATED DISTRIBUTION OF RESIDENTIAL GAS AND ELECTRICITY USE



NATURAL GAS



ELECTRICITY

AVERAGE RESIDENCE, UNINCORPORATED EAST BAY DIVISION

1268 Therms Gas

	Therms	BTU X1000
Space Heating - 62%	786	78,600
Water Heating - 31%	393	39,300
Cooling - 5%	63	6,300
Other - 2%	25	2,500

6733 kwh Electricity

	kwh	BTU X1000
Food Preparation & Preservation - 33%	2,222	7,577
Lighting - 21%	1,414	1,999
Space - 14%	942	1,332
Washing & Drying - 10%	673	952
Television - 8%	539	762
Water Heating - 7%	471	666
Other - 7%	471	666

*Source: PG&E, The Outlook, 1975.

Alternative A

"No Conservation" is defined as existing residential use for an average residence, unincorporated East Bay Division, 1974.

Natural Gas BTUX1000	Electricity BTUX1000	Total BTUX1000	Conservation
126,800	23,000	149,800	0

Alternative B

State standards of 1975. These address the problem of heat loss during the heating season almost exclusively. Although there are references to heat gain in summer and solar orientation of glazing, these standards do not lead to a material reduction in the use of air conditioning. Thus the impact of insulation and glazing standards of 1975 falls on space heating, primarily a natural gas use, not on electricity uses such as appliances. Electricity conservation, primarily through a slight reduction in air conditioning needs, and a significant conservation in natural gas will occur as a result of State standards of 1975, as delineated below.

Affecting natural gas: Saves 1/3 of natural gas for space heating. Space heating consumes 62% of residential natural gas. Therefore: 126,800 X .62 X .33 = 26,000 (BTUX1000) conserved.

Affecting electricity: Reduction in electricity, approximately 1/3 of space heating and cooling attributable to better insulation = 1,000 KWH, or 3,410 (BTUX1000) conserved.

Natural Gas BTUX1000	Electricity BTUX1000	Total BTUX1000	Total BTUX1000 Conserved	Percent Conserved Over A
100,800	22,000	122,800	27,000	20%

Alternative C

Anticipated State Standards by 1977. Standards now under review by the ERCDC speak to heat gain and the efficiency of mechanical systems and appliances. Such standards would further reduce consumption of natural gas in residences, and would also affect consumption of electricity to a greater extent than the standards of 1975. For the purposes of this study, the following conservation features are projected for post-1977 residences.

Affecting natural gas:

- pilotless ignition on furnaces, stoves and water heaters, conserving 25% of natural gas use in addition to conservation in B above.

Affecting electricity:

- glazing orientation, glazing shading, attic ventilation and energy efficient electrical mechanical systems and appliances, conserving 22% of electricity in addition to B above.

Natural Gas BTUX1000	Electricity BTUX1000	Total BTUX1000	Total BTUX1000 Conserved Over A	Percent Conserved Over A
75,000	17,800	92,800	56,000	37%

Alternative D. Alternative C Plus Solar Water Heating.

This would have a significant impact on either natural gas or electricity use. Water heating uses 31% of residential gas and 7% of electricity. Since the majority of water heaters in the county are gas fired units, the calculations were made for conversion from natural gas to solar. Based on 1/3 of gas use in Alternative C for water heating, and 80% conservation of that use by conversion to solar energy, we have--

Affecting natural gas:

75,000 (BTUX1000) X .33 = 25,000 X .80 = 20,000 (BTUX1000) conserved over alternative C.

Natural Gas BTUX1000	Electricity BTUX1000	Total BTUX1000	Total Conserved Over A	Percent Conservation Over A
55,000	17,800	72,800	77,000	48%

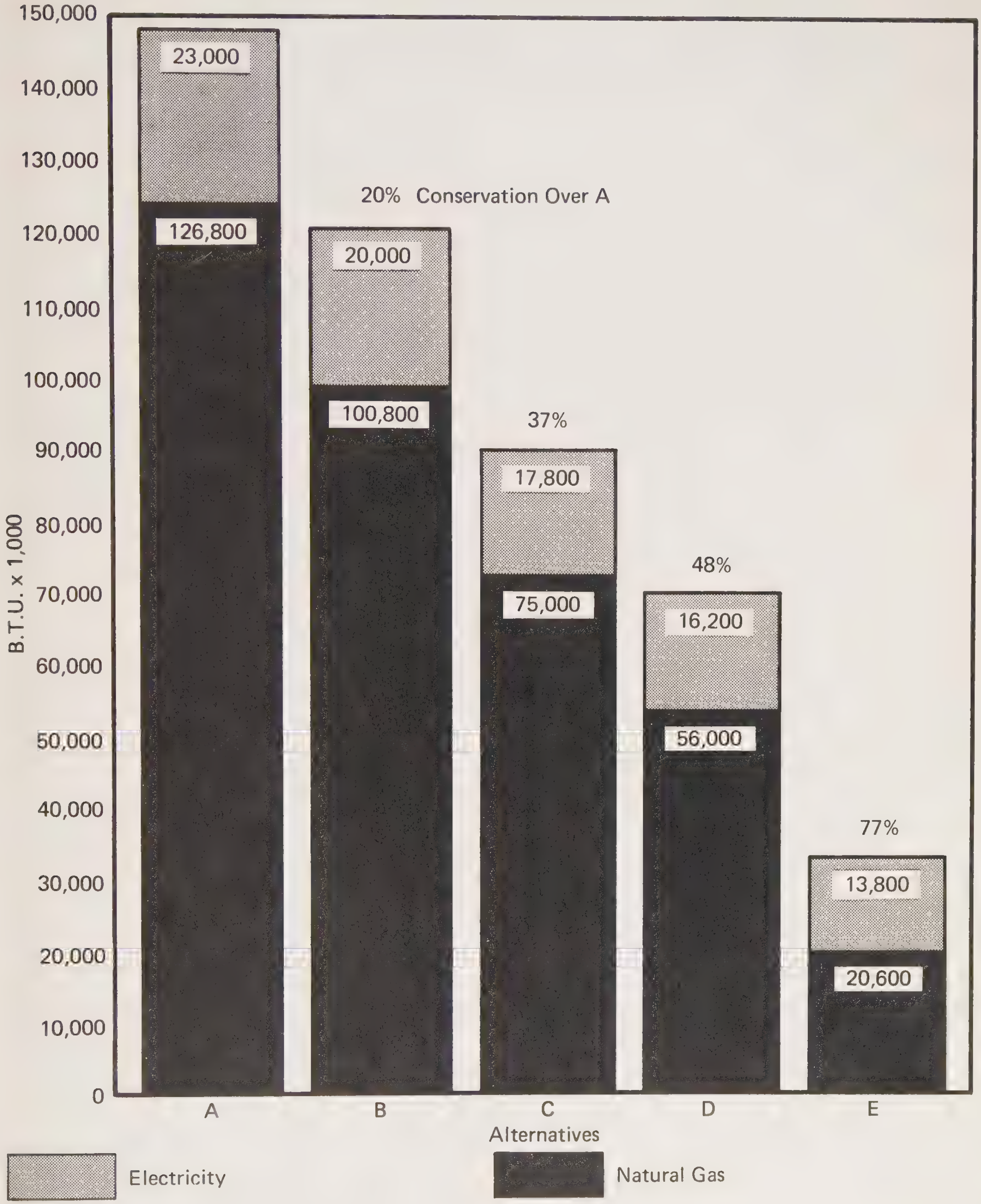
Alternative E. Alternative C Plus Water Heating and Solar Space Heating and Space Cooling.

This option yields conservation of 85% of natural gas used for heating, 80% of gas used for water heating, and about 95% of electricity used for space cooling. Under this alternative, space cooling is achieved by using the system in reverse. That is warm interior air is transferred to the heat storage system, using a small amount of electricity.

Natural Gas BTUX1000	Electricity BTUX1000	Total BTUX1000	Total Conserved Over A	Percent Conserved Over A
20,600	13,800	34,400	115,400	77%

These alternatives displayed visually in Table V-3 indicate that, for residential energy use, conservation options have a value of up to 77% of today's residential energy use, and if conservation programs are instituted the continuing high growth rate projected for the residential sector need not occur. Natural gas conserva-

Table V-3 RESIDENTIAL CONSERVATION ALTERNATIVES



tion for all alternatives is greater than for electricity. This is particularly true for Alternative B, State Residential Energy Standards of 1975. Additional standards are required for efficient use of electricity in buildings, along the lines of Alternative C, in order to achieve a significant degree of electricity conservation.

D. RESIDENTIAL CONSERVATION POTENTIAL IN CONTRA COSTA COUNTY

In order to examine conservation in the county-wide setting, an analysis was made for conservation alternatives assuming a program for new residences and retrofit of the existing housing stock. For this analysis, new development was based on the high-consumption residence expected to dominate residential development in the unincorporated county to 1980, described in Section III C, with a somewhat smaller building for the years 1980 to 1990.

Calculations were made for a 5 and 15-year period for conservation resulting from retrofit of 5% of the existing residential housing stock per year plus all new housing, with the conservation features of Alternatives C and D, conventional energy conservation features in C plus solar water heating in D. New construction estimates are those of the Contra Costa County Planning Department. The methodology is given in Appendix B.

Program 1.

<u>Alternative C - Anticipated State Residential Standards by 1977</u>

For the years 1975 to 1990:

New Residences	- 81,130
Retrofitted Residences	- 166,050, representing 5% per year of the existing housing stock of 213,403 units.
Conservation Value of Alternative C	- 37% of Alternative A (no conservation)

Under this program, new construction would require 75% of the energy conserved through the retrofitting program for the period 1975-1980, and new construction would require 26% of energy conserved through retrofitting for the period 1980-1990. Total conservation at the end of the program would be 4.92 trillion BTU's a year (4,920,000,000 BTUX1000), approximately equivalent to 848,000 barrels of oil.

Program 2.

Alternative D - Alternative C Plus Solar Water Heating

For the years 1975 to 1990:

New Residences	- 81,130
Retrofitted Residences	- 166,050, representing 5% per year of the existing housing stock of 213,403 units.
Conservation Value of Alternative D	- 48% of Alternative A (no conservation)

Under this program, new construction would require 66% of the energy conserved through retrofitting for the period 1975-1980, and 29% for the period 1980-1990. Total conservation at the end of the program would be 7.38 trillion BTU's a year (7.380,000,000 BTUX1000), approximately equivalent to 1,270,000 barrels of oil.

1. Swimming Pools

Because of the large number of swimming pools in the county--7,400 permits on record as of January, 1976--and an anticipated continuance of the trend to a large number of pools associated with large lot single family residences, and because a pool heater for an average-sized pool (1,200 square feet of surface area) consumes approximately 2,000 therms (200,000,000 BTU) annually for heating, there is an excellent opportunity for natural gas conservation in the county by the use of solar energy to heat pools.

It is estimated that 75% of these pools are heated by gas. Conversion of 6,000 pools to solar heating would conserve 6,000 X 2,000 therms per year = 12,000,000 therms (1,200,000,000,000 BTU), enough to provide total natural gas for 16,000 residences designed to the standards of Alternative C, or 75% of residential construction to 1980.

E. NON-RESIDENTIAL CONSERVATION POTENTIAL

Types of uses which lend themselves to conservation are listed for each type of non-residential use. Where conservation estimates are given, they should be considered very rough estimates subject to many individual factors on the site and in buildings. County-wide conservation evaluations for non-residential uses were not made because of the great number of factors required to be considered in each individual case. However, the items listed are usable as conservation examples. The extent to which any of these conservation measures will be implemented in the near future is not known.

1. Non-Residential Buildings

Energy use standards for non-residential buildings come from several sources. For office buildings, the U. S. General Services Administration (GSA) recommends an energy budget of 55,000 BTU per gross square foot of floor per year. Design standards are also promulgated by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE). A study by Arthur D. Little concluded that the use of ASHRAE 90 standards alone could not achieve the GSA energy budget for office buildings (Table V-4).

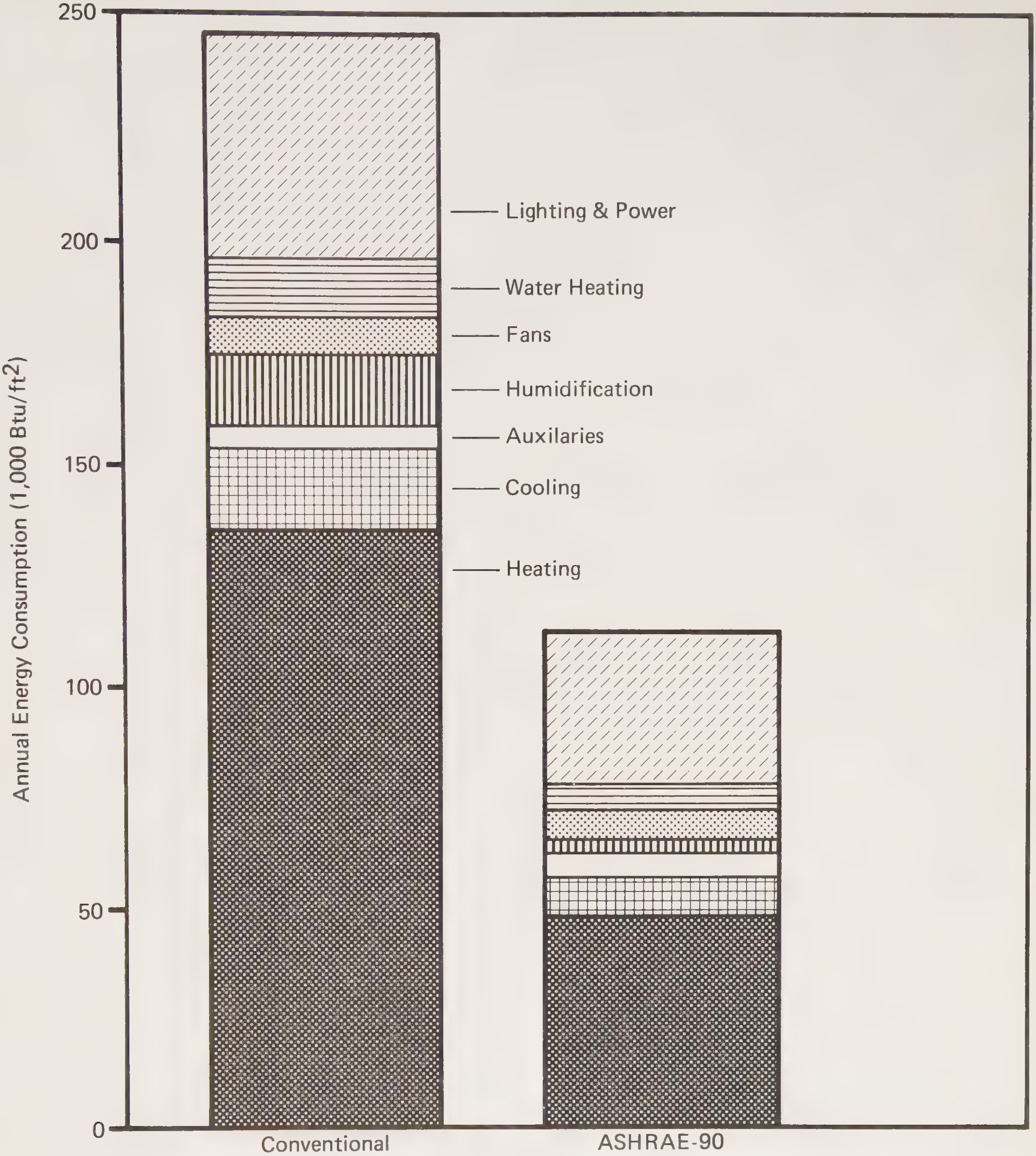
For non-residential buildings other than office buildings, standards have been prepared by and for the State of Florida. Other standards are in preparation. It would be difficult to reach Florida standards in Contra Costa County if only conventional means are used for heating and cooling. Analysis of selected County buildings reveals that, for office buildings, County office buildings range from 26% to 239% more than the GSA standard of 55,000 BTU per gross square foot (gsf) per year, and for other public buildings the Florida standards are exceeded from 1% to 128%, with the Boys Ranch 13% below the Florida standard. (See Table V-5) This illustrates that non-residential buildings are highly individual in their energy efficiency and have great variations in energy use on a gfs basis. Because of this, each building requires separate evaluation in determining the feasibility of adding conservation features beyond that state energy conservation standards which go into effect in 1977.

Operations in Existing Buildings

From 30 to 50 percent reductions in energy use in County-owned buildings were achieved by the Building Maintenance Department in 1972-3 through operating and maintenance changes and without any capital expenditures. Continuing some of these programs has resulted in higher energy use than in the 1972-3 period, but less use than in previous years. Analysis of several County buildings has revealed additional low-cost or no cost measures which are not universally applicable, but indicate the range of factors which may be associated with specific buildings, as well as the need to examine each situation individually. The recommendations include:

- Turn off gas fireplace logs while air conditioning is operating
- Open blinds for natural light and turn off lamps
- Shade air conditioner air intake
- Plant trees to shade glazing
- Avoid using lights and HVAC systems when building is not in use
- Revove luminaries to conform with maximum capacities allowed by Title 24, Energy Conservation Standards for Non-Residential Buildings
- Use operable windows for natural ventilation

Table V-4 COMPARATIVE ANNUAL ENERGY CONSUMPTION, CONVENTIONAL BUILDINGS VERSUS ASHRAE 90-MODIFIED PROTOTYPICAL OFFICE BUILDING STANDARDS, WESTERN UNITED STATES



Source: Arthur D. Little, Inc., An Impact Assessment of ASHRAE 90-75, prepared for FEA, U.S.G.P.O., 1975.

TABLE V-5: ANALYSIS OF SELECTED COUNTY BUILDINGS

Description	BTU/gsf (Electricity)	BTU/gsf(Gas)	Total BTU/gsf/year	Highest Recommended BTU/gsf/year	Percentage Over Recommended Standards
San Ramon Library	53,175	60,149	113,324	89,100[1]	+ 27%
Richmond Health Building	82,526	119,775	202,301	55,000[2]	+268%
San Pablo Library	30,305	84,312	114,517	89,100[1]	+ 29%
George Miller Center	36,956	105,992	142,948	62,800[1]	+128%
Social Service-Pleasant Hill	66,758	7,822	74,580	55,000[2]	+ 36%
Food Control Building	76,758	58,943	135,701	55,000[2]	+147%
Juvenile Hall	------	117,595	146,820	145,609[1]	+ 1%
Social Service-El Sobrante	44,326	58,987	103,313	55,000[2]	+ 88%
Pleasant Hill Building	76,764	109,465	186,219	55,000[2]	+239%
Social Service-Pittsburg	68,300	36,155	104,455	-------	+ 39%
Boys' Ranch	------	93,393	134,923	156,000[1]	- 13%
Lafayette Library	96,321	100,506	196,827	89,100[1]	+121%
Moraga Library	98,015	69,976	167,991	89,100[1]	+ 88%
County Administrative Center	64,159	46,913	111,072	55,000[2]	+102%
Richmond Administration Building	30,833	102,822	133,661	55,000[2]	+143%
Pinole Valley Library	86,687	56,164	142,861	89,100[1]	+ 60%
El Sobrante Library	44,198	59,395	103,593	89,100[1]	+ 16%

[1] Florida Standards, Buildings Other Than Office Buildings [2] GSF Office Building Standards

2. Parks

Significant natural gas conservation can be achieved by a pool heating shift to solar energy. For 9 months pool use, 60 to 80 percent of pool heating can be provided by solar energy and for 12 months pool use, about 50 percent, if low-efficiency trickle plate divices are used. High efficiency systems can provide up to 100% of pool heating needs providing that heat loss is minimized by covering the pool surface when not in use. Park pool energy use in analyzed in Appendix A.

Heat loss and heat gain in buildings can be reduced by insulation, attic ventilation, shading glazing in summer, and providing vestibules in areas where exterior doors are opened frequently. Conservation: approximately 30% of space heating and cooling energy.

Maintenance shop energy can be conserved by the use of energy-efficient motors. Conservation potential up to 50 percent.

3. Municipal Water Supply

Energy required to pump and treat water may be conserved by using wind pumps with fueled backup. More efficient pumps and avoiding oversized pumps would achieve energy conservation up to about 20 percent. Water conservation measures are also energy conservation measures.

4. Solid Waste

Conservation in the collection and transportation of waste can be achieved by:

- Energy efficient vehicles
- Reducing frequency of pickup
- Curb pickup (reduces time vehicles stand)

Recovery of material and energy resources from solid waste appears to be underway. Plans include generating electricity by burning suitable parts of trash isolated by recovery operations.

5. Sewage Treatment

The total energy consumed in wastewater treatment depends on the treatment processes used. Advanced chemico-physical treatment requires about 5 times as much energy as biological processes to achieve similar water quality. Biological processes, including activated sludge, trickling filters, oxidation ponds, and water lilies for absorbtion of heavy metals (now used in southern states) would reduce energy required for chemical processes, and reduce the energy required to produce and transport those chemicals. The Energy Task Force of the State Water Resources Control Board estimates that a secondary treatment activated

sludge treatment plant can be made 70 percent energy self-sufficient by utilizing sludge digester gas as fuel. Salable products such as methanol and alcohol can also be produced--products which themselves have an energy value. All of these processes are now being used in this country.

6. Street Lighting

Conservation in street lighting can be achieved by:

- Shifting to sodium vapor lamps (requires PUC rate setting before this can be implemented)
- Turn off lamps not required for safety
- Wider spacing of poles
- Refraining from approval of general street lighting in residential areas
- Reducing number of hours of operation. For example, turning off lamps from 1 am to 5 am

VI ECONOMIC FEASIBILITY

A. CAPITAL COSTS

The power company electricity growth projections are based on historical use increase patterns established in the 1950-75 period of rapid population growth and declining electricity prices, plus a trend to replace more efficient gas with electicity for home uses. In the era we are now entering, with shortages, higher prices, and conservation regulations, high energy growth rate projections may be inappropriate. This is especially true for that portion of historic electricity growth rates which was dependent on the continued erosion of efficiency. According to Conservation and Peak Power - Cost & Demand, by Goldstein and Rosenfeld, Lawrence Berkeley Laboratory report 4438, prepared under the auspices of the U.S. Energy Research and Development Administration, California's growth in electric energy demand could be held to 1.2% annually, not the overall 6.7% projected by PG&E for the period 1975-1985. The analysis of residential energy use prepared for this report indicates that a social decision, backed up with investment, cannot only reduce the residential electricity growth rate in Contra Costa, but can provide for anticipated levels of development and still reduce the residential energy demand. If the cost of conservation is less than the cost of developing a new power source and continuing wasteful consumption, as several reports indicate, then economic incentives should be aimed at stimulating conservation, not power development.

The LBL report cited above states a range of capital costs for construction, fuel and transmission of peak power of 50¢ a watt for inefficient fossil plants, $1.00 a watt for modern base-load fossil fuel plants, to $2.00 a watt for nuclear. A 50 gallon residential water tank, supplying 140 degree F water, draws an average of 500 watts all year, and thus requires a capital investment from $250 to $1,000, the cost of which is distributed among all customers. Solar water heating as an original installation requires an investment of approximately $700 and would conserve an estimated 80% of an entirely fossil-fueled system. Although the investment attraction to an individual purchaser is based on long-term utility bill savings, government policy, regulation, and economic incentives can respond to the broader economic issue, plus significant environmental impact differences, in deciding whether to continue to support new power plant development or conservation. For example, roughly 100,000 electric water heaters are sold in the state each year (quantity for Contra Costa County not known). If the state acted to prevent this use, there could be a savings of about 50 Megawatts (MW) of new demand each year, or 500 MW of capacity not required after 10 years. State policy directed towards conservation would reduce electricity need, and also reduce consumer costs increases. Whether or not sufficient gas will be available to assist in electricity conservation is a matter of speculation.

B. ALTERNATIVE SOURCES

Very little information is available on the economic feasibility of large scale exploitation of solar and wind resources. If the electricity cost rises used in this study prove reasonably accurate, and electricity costs rise faster than general inflation, there is a strong possibility that wind energy will become competitive with foreign oil or nuclear energy

C. RESIDENTIAL BUILDINGS

Estimating the economic feasibility of alternative sources and conservation requires dealing with a great number of uncertainties, including the future availability of fossil fuels, rates of increase in the cost of conventional energy sources, initial and operating costs of conservation devices and alternative sources, technological developments, and the form and extent of economic incentives and disincentives.

For the purposes of this study, a simplified method of determining the time to recoup capital investment (payback period) was devised to examine the economic feasibility of conservation in new residential buildings. The assumptions used include:

- Opportunity cost of investment at 9% per year
- Inflation at 6% per year
- Baseline residential energy use for comparison of alternatives. Average Residential Use, Unincorporated, PG&E East Bay Division, 1974, was selected as a conservative baseline. Although projections of energy use in future new housing is higher for single family detached housing, it was considered appropriate to select energy use figures more reflective of housing throughout the County, with a lower percentage of the high cost, high income housing anticipated to dominate the unincorporated County.
- Natural gas and electricity cost rises. This is the factor most subject to speculation. PG&E is advising its large customers to expect a 30 to 35 percent increase in the next 12 months, and perhaps an equivalent increase in the following 12 months. The overall rate of increase over the last 18 months, January 1974 to June 1976, has been at a 40 percent per year rate. On the other hand, the PUC appears intent on holding the line somewhat on residential costs through its "lifeline" rate structure for residential consumers. Although the revenues lost from residential sales are transferred to commercial and street lighting customers and thus appear in the residential consumers' property taxes and cost of goods, maintaining artifically low rates for the first 300-500 kwh of electricity for residential use was considered in cost-rise estimates. Also, utility rates are expected to level off at an undetermined future time. For this study, costs after 1987 were estimated to rise at a rate equivalent to general inflation (Table VI-1). No special effort was made to find conservation investment attractive. Rather, an effort was made to define a very conservative set of factors in order to avoid bias in favor of conservation and alternative sources.
- Maintenance costs and lifetimes of alternative systems were assumed to be equivalent and are not included as a cost factor. Insulation and solar collectors may last the life of the building. Energy-efficient mechanical systems and appliances were assumed to have a lifetime equivalent to energy-wasteful mechanical systems and appliances.
- Initial costs are for new construction of mass housing developments. Costs of retrofit and individual solar designs would be higher unless homeowner labor is used, in which case costs could be lower.

TABLE VI:1: NATURAL GAS & ELECTRICITY COST INCREASES, RESIDENTIAL USE
(Estimated annual rate of increase reduced 6% to reflect general inflation)

Year	% Annual Rate of Increase	Electricity $ Per kwh	Annual Cost 6733 kwh $	Natural Gas $ Per Therm	Annual Cost 1268 Therms $	Total Annual Cost $	Cumulative Utility Costs $
1976	18						405
1977	18	.03	201.99	.16	202.88	405	882
1978	18	.0354	235.66	.1888	240.92	477	1,488
1979	18	.0418	276.05	.2228	329.68	606	2,204
1980	18	.0493	323.18	.2629	393.08	716	3,006
1981	6	.0523	383.78	.3102	418.44	802	3,854
1982	6	.0554	403.98	.3288	443.80	848	4,747
1983	6	.0587	424.18	.3485	469.16	893	5,693
1984	6	.0622	451.11	.3694	494.52	946	6,691
1985	6	.0659	478.04	.3916	519.88	998	7,741
1986	6	.0699	504.98	.4151	545.24	1,050	8,863
1987	0	.0741	538.64	.4400	583.28	1,122	10,020
1988	0	.0785	565.57	.4664	591.40	1,157	11,177
1989	0						12,334
1990	0						13,491
1991	0						14,648
1992	0						15,805
1993	0						16,962
1994	0						18,119
1995	0						19,276
1996	0						20,433
1997	0						21,590
1998	0						22,757
1999	0						23,914
2000	0						25,071

Source: Contra Costa County Planning Department

Note that at an 18 percent rate of increase, costs double in approximately 4 years, and at a 12 percent rate of increase, costs double in less than 6 years. Thus the rate of increase is highly significant in the operating costs of a home over its 50 year life. A discussion of life-cycle costing is found in Appendix C.

Using costs from Table VI-1, and residential alternatives as described in Section V, Conservation Potential, the payback period of conservation and solar alternatives in new residential buildings was derived. Baseline energy use, expressed in Alternative A, is PG&E's 1974 estimate for the unincorporated East Bay Division. This estimate is low for several unincorporated communities in this County, but is used as representative of the County as a whole.

Alternative A: No investment, no conservation is represented in Table VI-2
Estimated use - 1236 therms gas
6733 kwh electricity

Alternative B: 1975 state standards for insulation and glazing.
Estimated investment - $700
Estimated conservation - 236 therms gas
283 kwh electricity
Total conservation over A - 17%

Alternative C: Anticipated state standards for 1977 for attic ventilation, shading, glazing, mechanical and appliance standards for energy efficiency.
Estimated investment - $1,300
Estimated conservation - 486 therms gas
1472 kwh electricity
Total conservation over A - 37%

Alternative D: C plus solar water heating.
Estimated investment - $2,100
Estimated conservation - 676 therms gas
1983 kwh electricity
Total conservation over A - 48%

Alternative E: C plus solar water heating, space heating, and space cooling.
Estimated investment - $9,300
Estimated conservation - 1031 therms gas
2863 kwh electricity
Total conservation over A - 77%

Table VI-2 **ALTERNATIVE A** Investment: None
Conservation: None

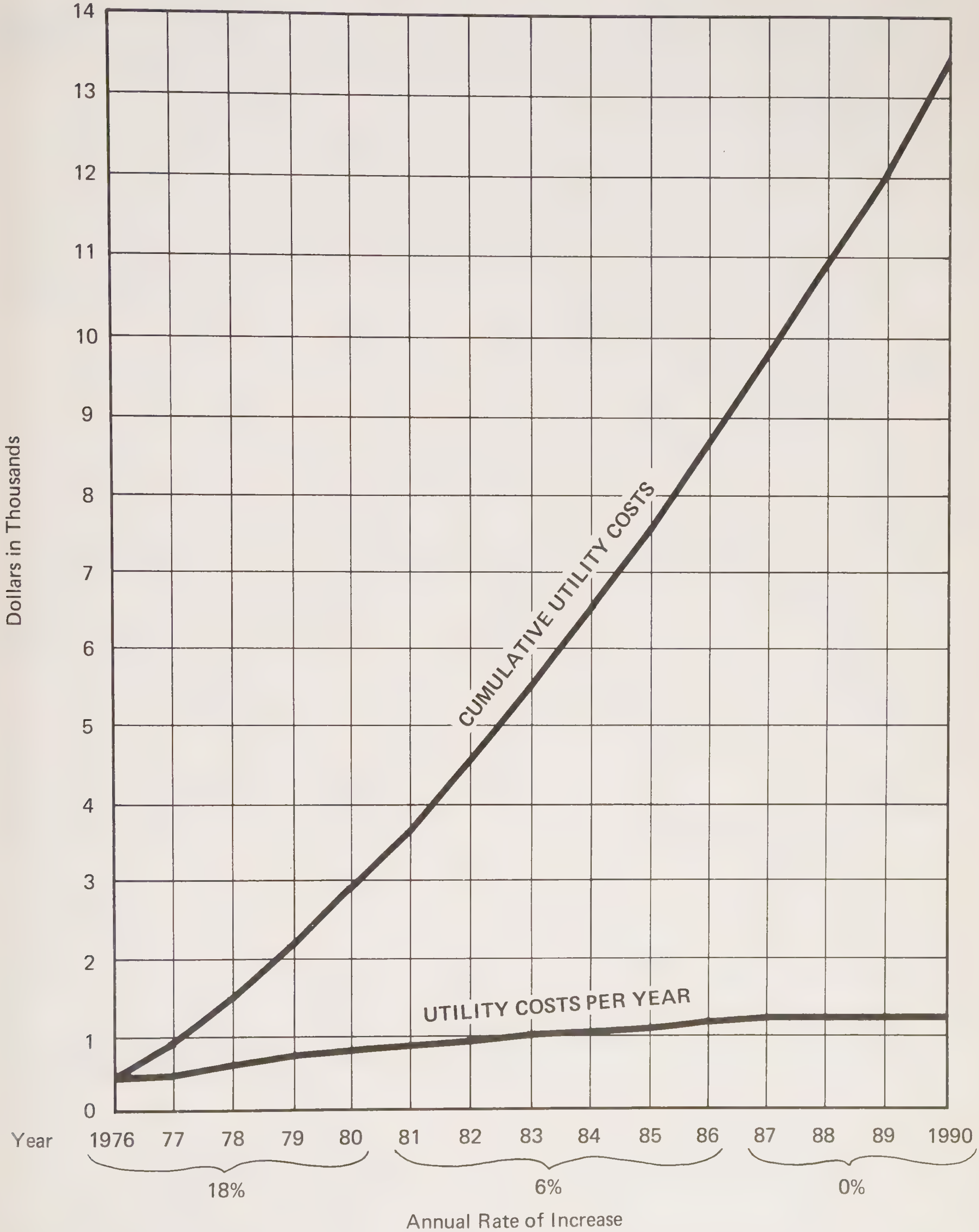
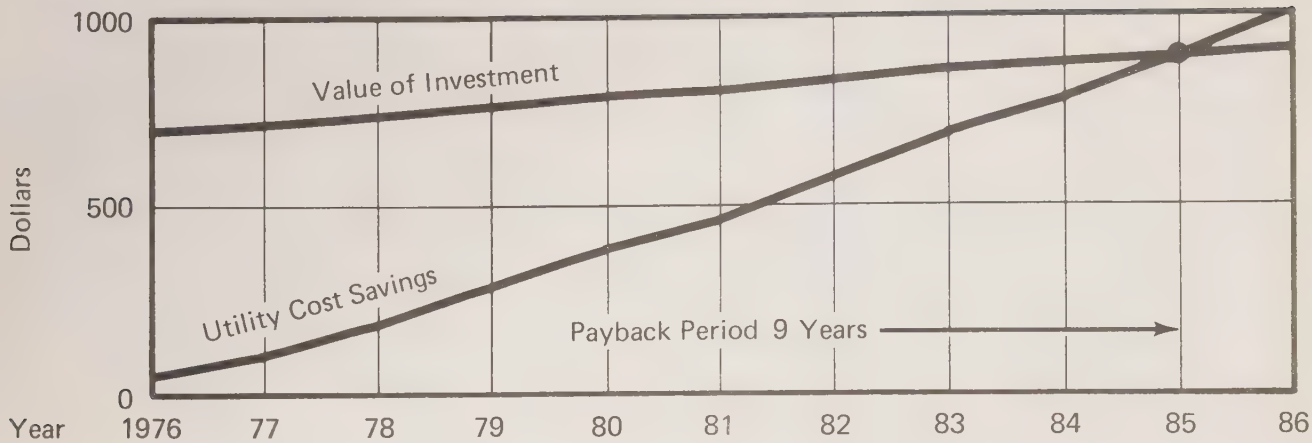
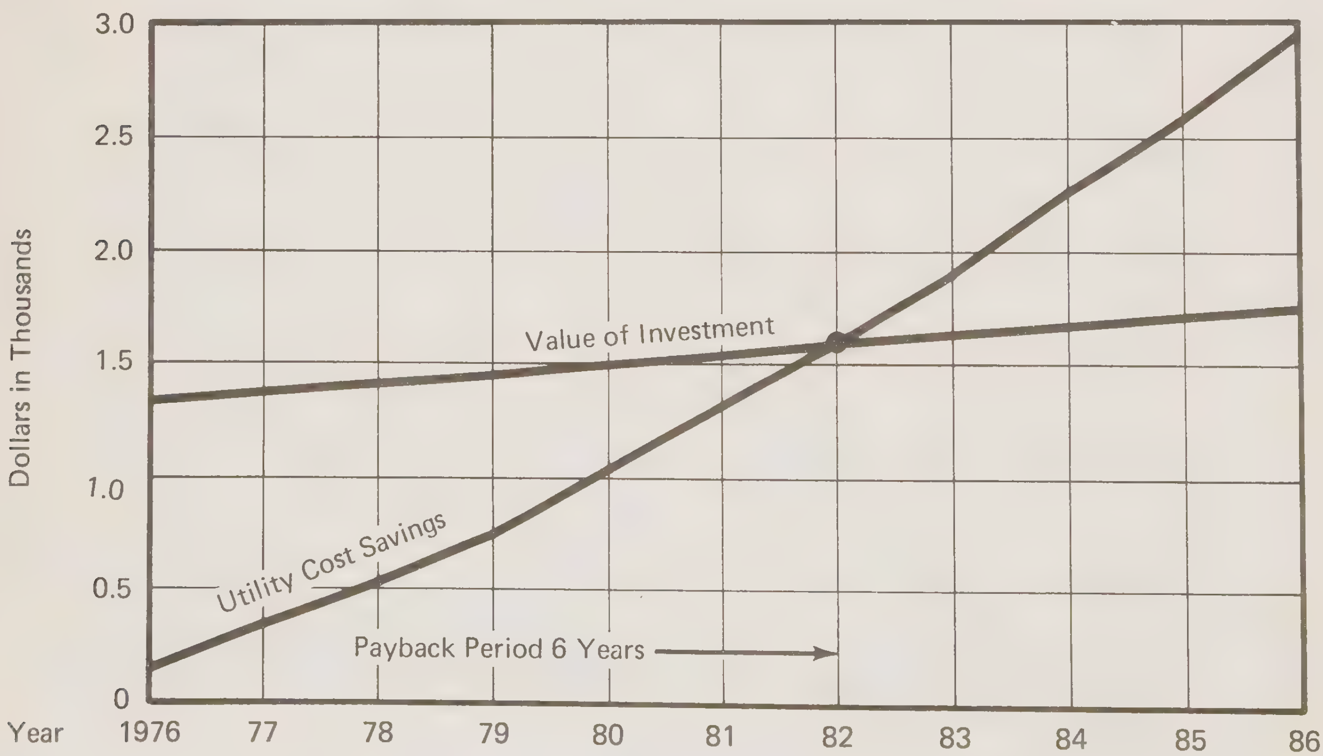


Table VI-3 ALTERNATIVE B



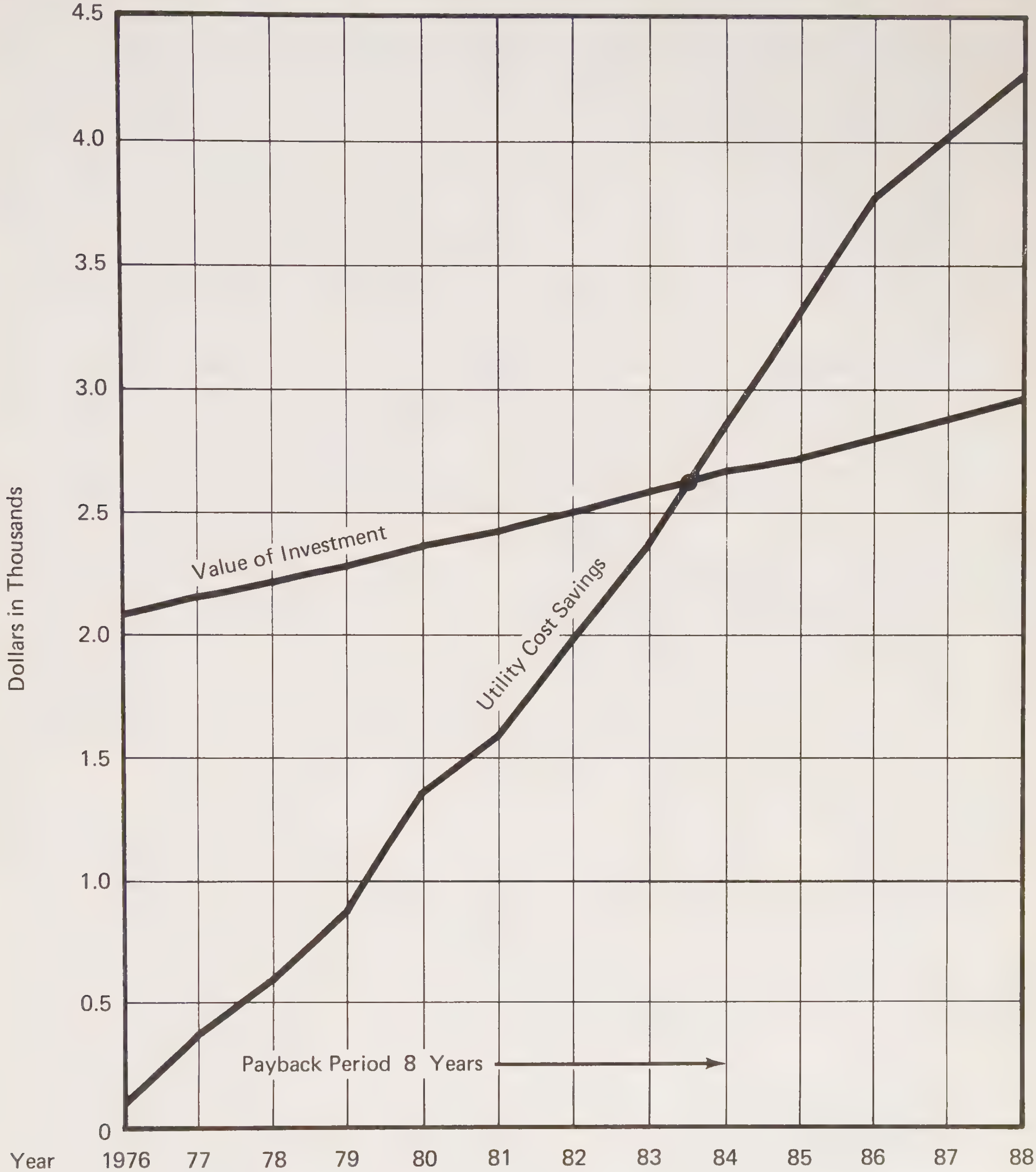
Investment: $700
Conservation: 17% of A
(State Standards for insulation and glazing)
Payback Period: 9 Years

Table VI-4 ALTERNATIVE C



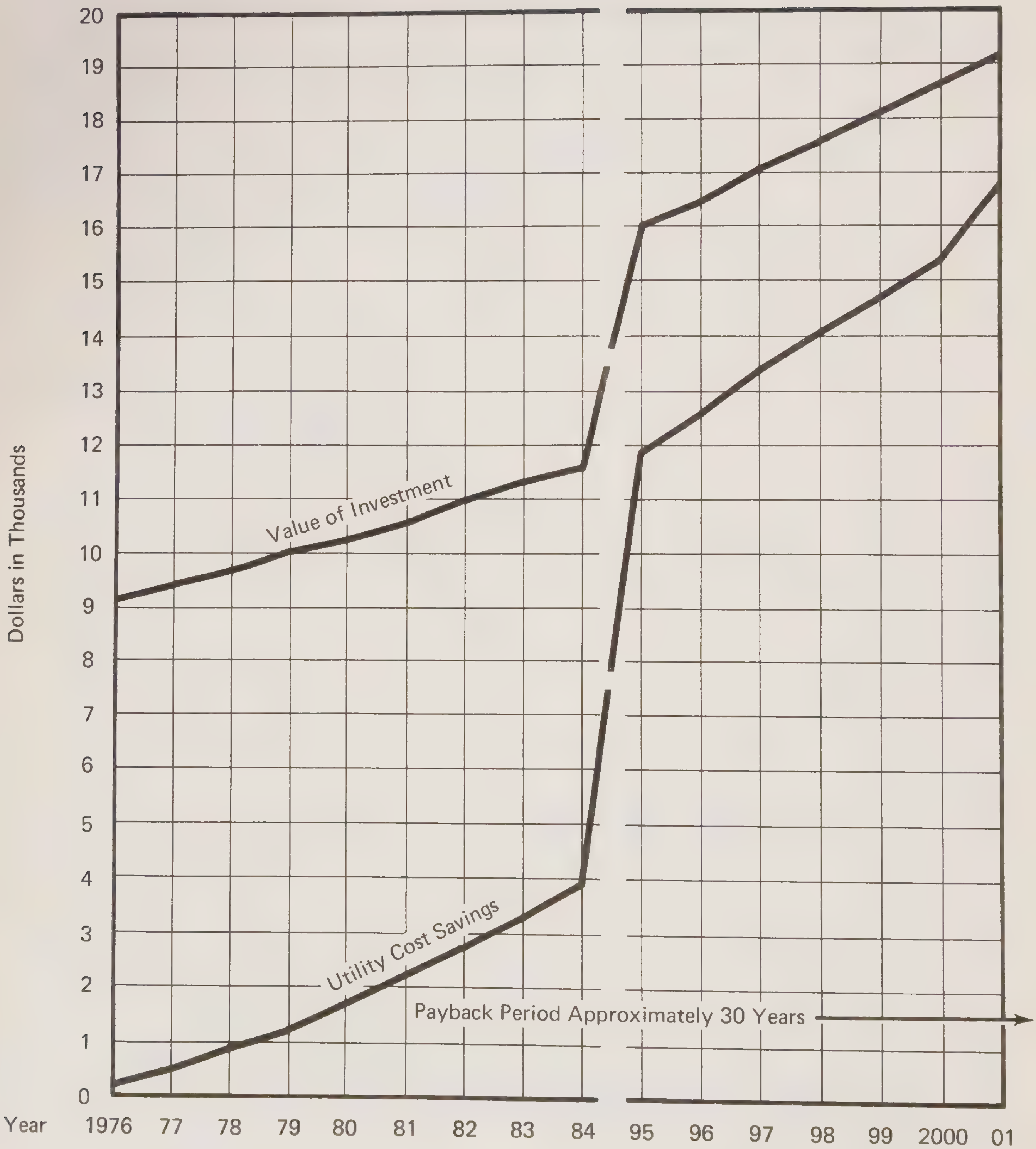
Investment: $1300
Conservation: 37% of A
(Alt. B plus additional features)
Payback Period: 6 Years

Table VI-5 ALTERNATIVE D



Investment: $2100
Conservation: 48% of A
(Alt. C plus solar water heating)
Payback Period: 8 Years

Table VI-6 ALTERNATIVE E



Investment: $9300
Conservation: 77% of A
(Alt.C plus solar water heating,
space heating and cooling)
Payback Period: 30 Years

Factors which make the case for conservation stronger, but which were not figured in the alternatives include the following:

- Conservation investment adds to the value of property, and by 1978 will doubtless add to the marketability of buildings provided with conservation features as a result of public awareness.

- Construction cost savings are not included, but could be used to reduce the initial investment. Savings can be achieved by providing smaller mechanical systems, for example.

- Alternatives B and C are not voluntary, but are, or are expected to be, required in all new residences by the ERCDC. Only "going solar" is open to choice in new development, although all options are open for retrofit of existing buildings.

- Alternative D does not deal with solar water heating as a separate item, so its economic feasibility is somewhat obscured by being combined with Alternative C. However, since the payback period for D, with solar water heating, is only 2 years longer than for C, without solar water heating, this indicates a very strong feasibility for solar water heating. Estimates for solar water heating alone are reported to yield a payback period of 6 to 8 years.

Costs of retrofit in residential buildings are highly variable. Ceiling insulation is estimated to cost from $300 to $500 for buildings with a crawl space, but would be much more costly if applied on top of a flat roof or beam ceiling building. Retrofit wall insulation is also much more costly than original installation. For solar retrofit, costs can be less than for new construction if family labor is used, or can be virtually prohibitive if the building lacks warm air ducts or other structural features needed to distribute and store solar energy.

1. Swimming Pools

As of January 1976 the County contained 7,420 permanent swimming pools and an unknown but large number of plastic above-ground pools. In areas of the unincorporated county expected to undergo rapid development in the decade to come, swimming pools are constructed on 10 percent to 25 percent of residential lots. The large number of existing pools and anticipated future pools make this energy use significant in the County. As a luxury use, it may be disallowed for more connections by 1978.

There are now several solar pool heating systems being marketed in California. The costs vary from about $300 to $2,000, estimated system lifetimes vary greatly, and the estimated number of months of heating from the systems also varies. In all cases, natural gas heating can be eliminated for a 4 to 6 month season, and for high efficiency systems, all year pool heating and sauna or therapy pool heating can be provided if the water surface is covered to retain heat while not in use.

TABLE VI-7: BENEFITS AND COSTS OF SOLAR POOL HEATING, AVERAGE RESIDENTIAL SWIMMING POOL

Type of Heater	Estimated Life in Years	Initial Cost in Dollars	$ Savings in 2000 Therms of Gas From 1977 Over Life Span of Unit	Benefit Cost Ratio	B/C Ratio With 10% Tax Credit
Floating Plastic Wafers	3	300	1,500	5.1	NA
Low Efficiency Plastic	10	1,200	9,900	8.3:1	9.2:1
High Efficiency Collectors	20	2,000	31,000	15.5:1	17.2:1
Gas Pool Heater (Given for Comparison)	13	650	(Gas Cost) 14,998	NA	NA

The benefits so clearly outweigh the costs for all systems it was not deemed necessary to use a more sophisticated means of demonstrating feasibility. The 10% tax credit is presently available in California. The question may be academic if gas pool heater connections are disallowed. This costing method is described in Appendix C.

Source: Contra Costa County Planning Department. Cost data from solar companies

D. NON-RESIDENTIAL BUILDINGS

1. New Construction

Recent studies seem to agree that new buildings designed to meet prescriptive and performance standards have not only a lower life-cycle cost, but also a lower first cost. Non-Residential Energy Conservation Standards, Title 24, Econmic and Energy Effectiveness Study, prepared by Carter Engineering Corp. for the State of California, showed slightly increased initial costs for conservation features. In some cases those costs were offset in the first year by energy cost savings. Similarly, the A.D. Little study, an impact assessment of ASHRAE 90-75, concluded that "The initial construction costs of those buildings modified under the (GSA) standard's prescriptive/performance approach were shown to be less than those of conventional buildings."

Most of the capital savings are attributable to reduction in heating, ventilating and air conditioning (HVAC) equipment sizes and reduced glazing area. Design costs maybe higher, but the A.D. Little study found the payback period for design costs to be less than one year by reduced energy costs.

2. Operations and Retrofit in Existing Non-Residential Buildings

From 30 to 50 percent reduction in energy use in County-owned buildings was achieved by the Building Maintenance Department in 1972-73 through O & M changes and without any capital expenditures. Energy use in these buildings is, in 1976, higher than for the earlier emergency period, but lower than for the pre-1972 years, indicating adequate comfort and convenience levels within a conservation-oriented O & M program. Measures requiring capital investments must be evaluated individually to weigh conservation and economic benefits and costs. Experience with retrofitting to conform with state energy standards upon change of occupancy, as required by Title 24, will, in time, give a basis for calculating economic impacts.

In order to examine the economics of solar retrofit, life cycle cost analyses were prepared for two County buildings, one a residential use with a high use of hot water for cooking, bathing, and laundry (building A), and one a library (building B). The present value costing method used in these analyses is discussed in Appendix C.

Building A

Building A uses approximately 95,000 therms of natural gas annually for water heating. A solar water heating system that would supply approximately 90% of the total requirement would cost approximately $300,000 to construct and would yield a 49% lifecycle saving over operating the conventional system for a 20-year period, as shown in Table VI-8. The conservation value is 95,000 therms x 90% x 20 years, or 1,710,000 therms (171,000,000 BTU X 1000), equivalent to 29,483 barrels of oil.

Building B

This library uses approximately 4,300 therms of gas annually, primarily for space heating through a low-temperature water-bed heating system. Solar augmentation, consisting of 1,000 square feet of flat plate collector plus storage, would yield the equivalent of approximately 2,400 therms of usable heat annually, or 55% of the total requirement, resulting in a 12% lifecycle saving over operating the conventional system for a 20-year period, as shown in Tablo VI-9. The conservation value is 4,300 X 55% X 20, or 47,300 therms (4,730,000 BTU X 1000), equivalent to 816 barrels of oil.

These examples indicate the cost effectiveness of solar water heating for domestic and other low-temperature applications. Using a different set of assumptions about the future could yield more favorable benefits. For example, if declining gas supplies forces a shift to more costly electricity, even a ten-year lifecycle cost would demonstrate economically feasible.

TABLE VI-8: SOLAR WATER HEATING, RETROFIT OF BUILDING A

LIFE CYCLE COST ANALYSIS
EXISTING GAS-FIRED DOMESTIC HOT WATER HEATING

Year[1]	System Cost[2]	Fuel Cost[3]	Salvage Value[4]	Subtotal Present Value[5]
0	(none)			
1		22,800		20,976
2		27,550		23,142
3		33,250		25,602
4		39,900		28,329
5		48,450		31,492
6		57,950		34,770
7		69,350		38,142
8		84,550		42,275
9		88,350		40,641
10		84,550		35,511
11		98,880		38,532
12		105,450		37,962
13		111,150		36,679
14		117,800		35,340
15		125,400		33,858
16		133,000		33,250
17		140,600		32,338
18		149,150		31,321
19		158,650		30,143
20		167,200		30,096
				660,399

[1]Twenty years approximates the projected service life of solar heating equipment used for comparison. Year 1 is 1978 since implementation would take approximately 24 months including decision-making, design, and construction.

[2]The gas-fired equipment is existing so there is no system cost. Since it would serve as a back-up for solar heating, maintenance and replacement would be required in any case.

[3]Fuel costs are computed at $.17 per therm for 1976, and inflated 20 per cent per year for the next ten years, and 6 per cent per year thereafter. Year 1 is assumed to be 1978.

[4]Any salvage value of conventional equipment would also apply to the solar heating analysis and is, therefore, irrelevant.

[5]Yearly cash flows are discounted at 9 per cent compounded annually.

LIFE CYCLE COST ANALYSIS
SOLAR-AUGMENTED SPACE AND WATER HEATING

Year[1]	System Cost[2]	Fuel Cost[3]	Salvage Value[4]	Subtotal Present Value[5]
0	(300,000)			(300,000)
1		2,280		2,098
2		2,755		2,314
3		3,325		2,560
4		3,990		2,833
5		4,845		3,149
6		5,795		3,477
7		6,935		3,814
8		8,455		4,227
9		8,835		4,064
10		8,455		3,551
11		9,880		3,853
12		10,545		3,796
13		11,115		3,668
14		11,780		3,534
15		12,540		3,386
16		13,300		3,325
17		14,060		3,234
18		14,915		3,132
19		15,865		3,014
20		16,720		3,010
				366,039

[1]Twenty years approximates the service life of solar heating equipment. Year 1 is 1978 since implementation would take approximately 24 months including decision-making, design, and construction.

[2]Due to the retrofit nature of such a system, the cost is necessarily a rough estimate and includes collectors, support structures, transfer systems, controls and additional storage. Solar maintenance costs were considered to be approximately equal to the savings on conventional equipment due to a 90% reduction in operating load.

[3]Fuel projections for the gas-fired equipment used in the back-up mode are approximately ten per cent of the total existing yearly load. Costs are computed at $.17 per therm for 1976, and inflated 20 per cent per year for the next ten years, and six per cent per year thereafter.

[4]The solar heating equipment is projected to be completely depreciated after 20 years.

[5]Yearly cash flows are discounted at 9 per cent compounded annually.

Source: Energy Study, Vol. III.

TABLE VI-9: SOLAR SPACE AND WATER HEATING, RETROFIT OF BUILDING B

LIFE CYCLE COST ANALYSIS
EXISTING GAS-FIRED SPACE AND WATER HEATING

Year[1]	System Cost[2]	Fuel Cost[3]	Salvage Value[4]	Subtotal Present Value[5]
0				
1		1,032		949
2		1,247		1,047
3		1,505		1,159
4		1,806		1,282
5		2,193		1,425
6		2,623		1,574
7		3,139		1,726
8		3,927		1,913
9		3,999		1,840
10		4,257		1,788
11		4,472		1,744
12		4,773		1,718
13		5,031		1,660
14		5,332		1,600
15		5,676		1,533
16		6,020		1,505
17		6,364		1,464
18		6,751		1,418
19		7,181		1,364
20		7,568		1,362
				30,071

[1]Twenty years approximates the service life of solar heating equipment used for comparison. Year 1 is 1978 since implementation of solar devices would take approximately 24 months including decision-making, design, and construction.

[2]The gas-fired equipment is existing so there is no system cost. Since it would serve as a back-up for solar heating, maintenance or replacement would be required in any case.

[3]Fuel costs are computed at \$.17 per therm for 1976, and inflated 20 per cent per year for the next ten years, and 6 per cent per year thereafter. Year 1 is assumed to be 1978.

[4]Any salvage value of conventional equipment would be likewise applicable to the solar augmentation analysis and is, therefore, irrelevant.

[5]Yearly cash flows are discounted at 9 per cent compounded annually.

Source: Energy Study Volume III

LIFE CYCLE COST ANALYSIS
SOLAR-AUGMENTED DOMESTIC HOT WATER HEATING

Year[1]	System Cost[2]	Fuel Cost[3]	Salvage Value[4]	Subtotal Present Value[5]
0	13,000			13,000
1		464		427
2		561		471
3		677		521
4		813		577
5		987		642
6		1,180		708
7		1,413		777
8		1,722		861
9		1,800		828
10		1,916		805
11		2,012		785
12		2,148		773
13		2,264		747
14		2,399		720
15		2,554		690
16		2,709		677
17		2,864		659
18		3,038		638
19		3,231		614
20		3,406		613
				26,533

[1]Twenty years approximatelys the service life of solar heating equipment. Year 1 is 1978 since implementation would take approximately 24 months including decision-making, design, and construction.

[2]Due to the retrofit nature of such a system, the cost is necessarily a rough estimate and includes collectors, support structures, transfer systems, controls and additional storage. Solar maintenance costs were considered to be approximately equal to the savings on conventional equipment due to a 90% reduction in operating load.

[3]Fuel projections for the gas-fired equipment used in the back-up mode are approximately 45 per cent of the total existing yearly load. Costs are computed at \$.17 per therm for 1976 and inflated 20 per cent per year for the next 10 years and 6 per cent per year thereafter.

[4]The solar heating equipment is projected to be totally depreciated after 20 years.

[5]Yearly cash flows are discounted at 9 per cent compounded annually.

E. TOTAL ENERGY SYSTEMS

Up to 30% of the power demand of new commercial, industrial and institutional development may not impact power companies at all. Total energy systems powered by on-site diesel engines are easier to manage for heat recovery and may have dollar benefits.

The following comparison of life-cycle costs and conservation was made for a one million square foot hospital, but a similar economic favorability is believed to occur for other buildings of 100,000 square feet or larger.

TABLE VI-10: LIFE CYCLE COSTS AND CONSERVATION, TOTAL ENERGY SYSTEM

	Power Source	
	Purchased	Diesel Electric
First cost (million $)	5.7	7.8
Life cycle costs (million $)	34.1	29.6
Life cycle fuel use	550	312

*Source: Conservation and Peak Power - Cost and Demand, Goldstein and Rosenfeld, Department of Physics and Lawrence Berkeley Laboratory, U. C. Berkeley, draft, December 8, 1975.

Table VI-10 is one of a growing number of examples demonstrating that dollar savings accompany energy savings, and that conservation is frequently cheaper than either new source capitalization or continued inefficient use.

F. ECONOMIC INCENTIVES

Technology exists today to conserve up to 75% of natural gas and electricity used in new residences, 50 to 70% of energy used in new non-residential buildings, an estimated 40% of industrial energy, and a probale 25% or more in transportation and agriculture, based on the conservation potential in this study, and studies made at the national level. On a per capita basis, industrialized and high income Sweden uses approximately 60% of the energy consumed in the U.S. Other industrialized nations also use far less energy per capita than this country, but conservation of resources has not been the historiacal pattern in America.

Conservation is a problem in economics, not technology. Economic factors up to now have encouraged the wasteful consumption of energy. Federally supported low energy prices, federal stimulation of suburban low density communities, the best highway system in the world, the biggest cars, disuse of railroad transporaation, the most windows and glass walls, the most gadgets, and probably the most interior and exterior lighting, rapid depreciation of buildings for tax purposes, a highly mobile population, (both leading to short term ownership plus lender and developer interest in first cost), public project construction funds from the limited resources of bonds but unlimited O & M funds hidden in taxes, power company rate structures and profits--these factors and many others have worked together to create a milieu of disregard of resource conservation and long-term costs. As one example, it is estimated that 50,000 solar water heaters in Florida fell into disuse as cheap gas became available there.

It takes time, often a generation, to change social attitudes, customary procedures, and administrative standards. Yet all sources agree that an energy crisis is upon us now and that it requires immediate action. Since the conservation problem is economic, and conservation is vital, economic incentives and disincentives should be designed to stimulate the earliest possible conservation practices. Most of the buildings and land use and transportation patterns which will exist 10 or 20 years from now already exist, so economic incentives need to stimulate retrofit programs as well as new construction, development, and industrial operations. An additional consideration is to insure that those on low and moderate incomes can share in the benefits of conservation.

Incentives and regulations, working together for conservation, can be expected to have as much impact in future as incentives and regulations for inefficient consumption have had in the past. As an example, the County contains over 14,000 rental residences (as of April, 1975), an unknown number of leased commercial and industrial buildings, and an increasing number of buildings leased by government. There is a distinct difference in interest when, as is now customary, the owner is responsible for the initial cost of heating and cooling equipment, lighting and other energy consuming devices, but the renter or lessee pays the utility bills. In order to include these buildings in retrofit programs a combination of regulation and incentives is advisable. A regulation shifting the utility cost to the building owner would lead to an earlier interest in retrofit, especially if combined with a tax rebate or other economic incentive, although rising utility bills alone are expected to become a strong incentive for conservation in the near future.

When public development construction funds come from one source and maintenance funds from another source, as is true of virtually all public, residential and commercial developments in the County, life-cycle costing may become an instrument of change in the immediate future by revealing an economic incentive for conservation. However, flexible budgeting and financing policies would often also be required in order to provide larger construction funds in cases in which initial cost is higher. Public buildings constructed with limited bond or grant funds, but operated and maintained through less limited tax funds, encourages wasteful energy use, not conservation. Since there is increasing evidence that energy efficient design, construction and interior systems do not necessarily increase the initial cost of

non-residential buildings (several examples are reported in Construction Weekly, November 13, 1975), building industry economics alone may be a satisfactory incentive for conservation in new construction providing that strong policy direction and standards are also provided and enforced equally on all.

The case for alternative sources and retrofit is more difficult. Initial costs are significantly higher for solar systems whether for new construction or for retrofit. Therefore, the time span over which the investment is recouped is long, and can be 25 years or more depending on individual conditions. In these cases the payback period may be equal to the estimated life of the system, so there would be no "profit" associated with use of the non-depletion energy source. A decision to "go solar" on a new building should be based on an acceptable formula for life-cycle costing. Life-cycle costing is also essential for retrofit in order to determine if the investment is worth while, given the estimated remaining lifetime of the building.

In order to examine different economic incentives, residential Alternative E, a solar home, was examined with two incentives:

1) The 10% tax credit on solar costs now in effect in the state. The net loan of $8,500 is calculated at 9.6% for 10 years, Alternative F.

2) A low interest loan, which may be available in California in 1977. Loans are calculated for 10 and 20 years, Alternative G and H respectively, at 6%.

Since using the opportunity cost of investment does not permit a meaningful observation of the benefits of incentives, the actual cost of the loan is used in these analyses and replaces the Value of Investment column in the previous examples. For these examples, the payback period indicates the number of years required for utility bill savings to equal the cost of the loan. For F and G, the payback period is between 12 and 13 years, and for H, between 14 and 15 years (Table VI-11). This costing method is discussed in Appendix C.

For non-residential buildings as well as residential buildings, low cost long-term financing appears to be a more productive incentive than a tax credit. However, the $2,000 tax rebate for new home purchase in 1975 was instrumental in reducing the inventory of new housing in the County, and is an example of the impact of a one time subsidy in the residential market. The state's present program of granting a 10% tax credit for the initial cost of solar devices may well prove a successful incentive in home retrofit actions.

The following types of incentives are largely the responsibility of the federal and state governments. Economic incentives provided by local governments are limited by limited local control over grant and loan funds and property assessment. Incentives and disincentives which may be considered include:

- Require lenders to give financing priorities to construction using alternative sources of energy.

- Lower property assessments on alternative energy devices.

TABLE VI-11: CALCULATION SHEET, ALTERNATIVES F, G, H.

Year	Alternative E Cumulative Savings	F Cumulative Cost $8,500 at 9.6%	G Cumulative Cost $9,300 at 6%	H Cumulative Cost $9,300 at 6%
1976	312	1,326	1,240	800
1977	698	2,652	2,480	1,600
1978	1,177	3,978	3,720	2,400
1979	1,772	5,304	4,960	3,200
1980	2,438	6,630	6,200	4,000
1981	3,183	7,866	7,440	4,800
1982	4,015	9,102	8,680	5,600
1983	4,954	10,338	9,920	6,400
1984	6,002	11,574	11,160	7,200
1985	7,176	12,810	12,400	8,000
1986	8,490	End Loan	End Loan	8,800
1987	9,883			9,600
1988	11,360) F & G) 12± Years			10,400
1989	12,925)			11,200
1990	14,200) H - 14±) Years			12,000
1991	16,343)			12,800
1992	18,207			13,600
1993	20,184			14,400
1994	22,279			15,200
1995	24,496			16,000
1996	26,854			End Loan
1997	29,349			
1998	31,994			
1999				

- Reduce utility rates where electricity is a backup to an alternative non-depleting source such as solar energy.

- Tie Community Development grants to conservation programs.

- Establish grants for home retrofit for low and moderate income groups.

- Widen the difference between "lifeline" gas and electricity use rates and rates for higher consumption.

- Provide low interest loans for conservation retrofit in residential and smaller non-residential buildings.

- Require owners of multiple residential and non-residential buildings to carry energy costs for at least five years after construction.

- Permit public project budget flexibility to provide funds for higher initial costs where life-cycle cost studies indicate long-term savings.

Local governments can:

- Base conservation investment in new public buildings and retrofit of existing buildings on life-cycle cost analyses.

- Require conservation standards to be met in leased buildings, or shift operating and maintenance costs to building owners.

- Reduce permit fees for conservation and alternative source features.

- Give priority processing to conservation-oriented projects to reduce developer's cost of financing.

- Incorporate conservation program into other programs administered by the County. For example, working the Federal Emergency Energy Conservation Program into housing rehabilitation.

Because of the long lifetimes of buildings, and the long-term energy consumption patterns built in at the time of construction, it is recommended that economic incentives and regulations be instituted at the earliest possible time.

VII. THE ROLE OF LOCAL GOVERNMENT

There are several areas of energy conservation action available to the County government, including:

1. Support for and cooperation with State and Federal actions and programs. Active efforts to utilize grant and loan program.

2. Conservation efforts in County-owned property (i.e., buildings, vehicles, equipment, and maintenance programs). Each division of local government is capable of examining its functions and operations from an energy point of view, but expert assistance may be required to advise on conservation.

3. Devise energy-conscious institutional arrangements such as public safety agency district boundaries, water service area boundaries, and the areas into which various utilities and services or public transportation are planned to be extended in future. These are joint functions of the Planning Agency and Local Agency Formation Commission.

4. Devise goals and standards for County functions and for the regulation and approval powers held by the several divisions of local government. For example, the Board of Supervisors can institute building code measures, administered by the Building Inspection Department, which will promote energy conservation beyond the provisions of State requirements, including partial forgiveness of permit fees.

The Planning Agency has distinct roles in any local government conservation program. It is the Planning Agency which, through its land planning and project review functions, has the greatest relevance to long-term energy consumption patterns in its jurisdiction. As we have seen, Contra Costa County has, and is planning to continue to build, large single family detached dwelling units on large lots -- a type of development which is high in energy consumption for initial construction, and, more importantly, is precisely the type of development which leads to the high energy growth rates projected by the power company. This pattern of long-term high energy consumption can be changed if there is a clear social commitment to do so, and Planning Agency actions can help effectuate a new conservation pattern in community development.

Through its General Plan powers the local government determines how much land will be available for conversion from agriculture to urban uses. The loss of food and fibre energy from land conversion is considered a permanent loss. The General Plan designates areas for various densities and intensities of uses, thus setting the framework of community development and the consequent basic types of buildings which will use energy, and by planning for the roads, parks, schools, and other public facilities which will be required to serve future development, also provides the framework for future energy consumption for initial construction of facilities and for long-term maintenance of these facilities.

It is sometimes pointed out that because small individual lots and attached and apartment dwelling units require less energy per person for construction and long-term operations, and because high density communities are more capable of supporting public transportation, high density development is preferable to low density development. This issue requires closer examination. Firstly, the conservation potential in buildings, as shown in earlier sections of this report, is large, with up to an 80% energy use reduction possible in residential buildings without significant life-style changes. These savings occur over the entire life of the building and outweigh the initial construction energy saved by constructing apartments with, for example, only 20 linear feet of street per unit versus 50 linear feet for a low density single family development. Long-term energy conservation depends more on the construction and interior systems of buildings than on energy required for site construction. Since urban land conversion represents a loss of former food and fibre energy production from that land, the opportunities provided by the single family lot for home agriculture should not be disregarded.

Contra Costa County has a commitment to low density suburban development. Residential growth in the next decade is expected to take place by completion of approved projects, in-filling, and re-activation of previously approved projects. With the exception of one or two areas which could be considered linear extensions into outlying agricultural areas, but for which a commitment to development has been made by the County, future development is planned for areas contiguous to existing development and for areas already partially developed. Given conditions today, projected development trends and community ideas for the future as expressed in the land use element of the General Plan, and given the conservation benefits which can be realized through project and building design, a commitment to conservation can achieve significant long-term conservation in Community Development.

The issue of energy use for transportation requires consideration. Low density suburban communities are very costly to provide with public transportation, but if this cannot be provided, there is a possibility that continued development may be disallowed for reasons of vehicular air pollution, and petroleum use. Federal research and development is beginning to focus on the internal combustion engine since industry does not seem to be able to respond rapidly enough to achieve Federal goals. One can perceive a future in which transportation energy will be greatly reduced. In areas such as Contra Costa County, this may be realized more through vehicle changes than through a re-direction in land planning.

Re-development areas are a different case. Re-development represents land conversion from one urban use to another, takes place in older urban centers, and has a different set of land assemblage and economic factors, including higher land cost. In these areas, urban density and energy relationships are a more appropriate consideration.

The question of whether or not energy resources and conservation are appropriate to become an element of the General Plan has been considered. Since it is essentially a policy document, the General Plan may be perceived as an appropriate vehicle for expressing energy policy for the local jurisdiction, as was done by the City of Indio.

While it would be unwise to discourage a local government from using this means of establishing policy, there are reasons why the General Plan format may not be the most effective means of implementing conservation programs, reasons which may be more relevant to a large metropolitan County such as Contra Costa than to a smaller, less diversified community. These include the following:

- Many divisions of local government need to be involved in conservation, but they do not all necessarily observe or conform to General Plans. For example, the County Assessor, Public Works, and Social Welfare agencies.

- The General Plan makes broad policy statements, but energy conservation is expected to occur through a wide variety of actions, most of which are specific in nature. It is questionable that the General Plan is the appropriate document to establish attic ventilation requirements, for example.

- These are the early years of conservation. Technology and public education will doubtless bring about change as we enter this new era of energy awareness. The next few years may be too early on to "harden" a jurisdiction's approach to energy use. General Plan policies, if they are specific enough to be effective, also may soon prove to be stumbling blocks to future actions.

- As pointed out in this report, County-wide conservation requires retrofit programs for the existing stock of buildings. It is not the traditional nature of the General Plan to speak to upgrading existing areas except for re-development, renewal, or improvements in public facilities. Recent state laws have given more substance to General Plan policies and recommendations than was true in the past. This increased power indicates a need to evaluate the appropriateness of expanding the subject matter of the General Plan more than in the past.

- In order to achieve County-wide conservation in an orderly way inter-jurisdictional cooperation is vital. Needed programs could fail if conflicts arise among cities, between public agencies, or between public agencies and the power company. County General Plan policies, adopted by the Board of Supervisors, have no power over the actions of the incorporated cities within the County and could be viewed as obstructing coordinated programs.

For the above reasons, it is not recommended that the State mandate an energy element to the General Plan, but neither should a local jurisdiction be prevented from using this vehicle to establish community policy if the local government finds it appropriate.

Having set the scene by the General Plan and the appropriate conforming zoning, review of proposed projects can reveal many ways in which conservation can take place, and by conditions of approval and/or regulation, can achieve the degrees of conservation described in earlier sections of this report. Certainly, site design is a major area of concern in project review. A case study prepared for this study (see Guidelines for New Development, Vol. II of this study) showed that redesigning a major subdivision project could conserve energy required for site construction by reducing the overall square footage of streets, and at the same time

maximize the number of individual lots with the north-south orientation most favorable for conventional housing, and so reduce the long-term energy required for street maintenance, street lights, and to heat and cool the buildings to be constructed on the lots. Design changes did not affect lot size, density, or in any other way cause distrubances in the proposed project or the existing zoning. Because Contra Costa County does not require landscaping in major residential subdivision projects, site planning review for tree placement, an important energy factor, could not be made.

At present, energy conservation in project review is in the early stages, and is more in the nature of applying judgment based on knowledge of conservation principles than on enforcement of regulations. For this reason, it is essential to retain the maximum in flexibility in project review so that, by cooperative efforts between staff and developers, the benefits of energy conservation can be achieved without losing sight of values presently perceived as equally important in marketing residential units, such as attractive lot layouts, amenities, street lights, setbacks, and other features more or less expected to be provided in many residential areas. In five to ten years matters which may be considered issues today are expected to become accepted by the public, and these concepts are now in the period of experimentation and evaluation which precedes the standardization of change. Without disregarding all the design concepts of the past, the following conservation principles can be applied to new developments:

- Minimize paved areas and utility and drainage lines.

- Orient lots with regard to the sun so that walls and glazing will be exposed to winter sun and, in areas where heat gain is an energy consideration, will be shaded from summer sun.

- Design project sites so that areas which would require excessive energy for construction and maintenance are used as open space. Steep slopes are an example of high-energy use areas.

- Provide landscaping, whether basic or complete, which will contribute to long-term conservation. In warm summer climates, shading pavement and roofs is particularly important. In some microclimate areas windbreaks may be provided by trees.

- Where appropriate, provide community recreation facilities to avoid subsequent energy for constructing and operating a multiplicity of recreation features in the project in future. In Contra Costa County, this has particular application to swimming pools. In some areas, 25% of homes have swimming pools, each using about 2000 therms of natural gas a year. Developments which provide a neighborhood pool can virtually eliminate this energy consumption.

Some of these design principles are used in review of Planned Unit Developments for reasons other than energy conservation. It is evident that the flexibility gained through PUD processing opens the door to energy considerations in project design without the need to "harden" conservation into regulations at this time. Therefore, encouraging projects to be PUD's would automatically provide many opportunities to achieve a level of energy conservation today which will be beneficial throughout the life of the project. Commercial and office developments offer conservation opportunities similar to residential development. However, conservation in non-residential buildings is both more technical and more complex than conservation in conventional residential buildings. This is even more true of industrial development, with as many conservation opportunities as there are energy-consuming operations.

Project review under the Planning Agency does not include the detailed study required to determine adequate conservation in HVAC systems, lighting, and operations in buildings. HVAC systems and lighting standards are the purview of the Building Inspection Department which enforces State and local requirements. The Planning Agency can contribute to conservation by ensuring that site design, building orientation, and landscaping will mitigate against an excessive use of energy for heating and cooling, and can protect the future value of solar systems through solar zoning.

For non-residential development, a major conservation tool of the Planning Agency is its responsibility to determine the adequacy of the Environmental Impact Report. The EIR is not adequate until energy-related issues have been explored and mitigations recommended. This brings to public and to regulatory agency view the conservation opportunities which may have been missed, and these opportunities can then be implemented as conditions of approval in the project approval process. Similar opportunities can be expected to occur for residential and public projects.

A purpose of this study is to determine ways in which the County, and particularly the Planning Agency can relate to energy resource needs and conservation. The following is a list of such actions, including policies suitable for adoption by the Board of Supervisors, recommendations for all divisions of County government, and actions specifically under the powers of the Planning Agency.

1. The Board of Supervisors should adopt a clearly stated position on energy resources, such as the following:

   - It is the policy of Contra Costa County to take all reasonable steps to reduce energy use in the County in order to avoid the risks of air pollution and energy shortages which could prevent the orderly development of the County.

2. Additional policy statements demonstrating cooperation with Federal and State programs, and inter-community cooperation are also needed:

   - It is the policy of Contra Costa County to cooperate with Federal and State energy goals and to actively seek programs to minimize energy use in the County.

   - It is the policy of Contra Costa County to encourage and lead cooperative conservation programs among the several cities and the County.

3. Specific actions by the Board of Supervisors could include:

   - Declaring invalid any deed restrictions or covenants which would prevent the installation of solar devices.

   - Establish an Energy Office to coordinate energy and other programs, including public education.

4. Each division of County government should be directed to examine its procedures and standards in order to determine ways in which energy conservation can be encouraged and implemented. The following list is not exhaustive, but gives a range of actions considered appropriate.

- Assessor - Reduce assessments for conservation features, particularly features which use alternative sources such as solar, wind or waste recovery energy. (Requires State implementation)

- Building and Grounds Department - Continue the successful conservation program which was begun in 1972 and recommend conservation investment in County buildings, especially where long-term cost savings would result. These recommendations could include panelization of lights, changes in mechanical systems, shading glazing, solar applications, and higher requirements for leased buildings. Institute a program of change to energy efficient vehicles and equipment.

- Public Works Department - Require energy conservation in new projects, particularly solar applications in new buildings or as retrofit where studies reveal economic benefits. Consider accepting dedication of substandard roads where energy conservation benefits have been demonstrated for such roads. Plan street systems and traffic signals to minimize standing vehicles. Design flood control and drainage works to avoid excessive energy use.

- Local Agency Formation Commission (not under the Board of Supervisors) - Consider the vehicular energy conservation benefits of re-districting and re-organizing the boundaries of service areas. This can be discussed in the EIR's for LAFCO actions.

- Parks and Recreation Agencies - Design recreation areas to attract vacationers who otherwise might travel long distances for camping and outdoor recreation. This could require a change in local recreation policies.

- Planning Commission - Consider the use of solar zoning. Encourage Planned Unit Development on small properties as well as for large projects. Require information on major subdivisions and commercial proposals sufficient for evaluating energy use at the site planning stage. For development in outlying areas, encourage the use of self-sufficiency devices, including solar energy, wind energy, and on-site waste management. Set conditions of project approval that will result in long-term energy conservation. Cooperate with Federal and State conservation goals in the administration of Federal and State funded programs for the County. Fully utilize Environmental Impact Report procedures to explore energy conservation opportunities. Consider the use of open space areas for wind-generated or sun-generated power installations where this would not cause a public safety hazard or damage agricultural values. Work with the power company and community agencies and groups to provide education on conservation and alternative utility sources.

- Building Inspection Department - Approve standards for structural safety of wind mill support towers and other alternative energy devices. Approve for use in the County features such as pilotless ignition devices. Reduce permit fees for alternative energy devices. Institute a program to require and enforce retrofit programs upon the sale of buildings. This could include ceiling insulation in all buildings, plus attic ventilation in climates with 400 cooling degree days a year or more.

- All departments - Increase awareness of conservation through lighting, ventilation, energy-efficient equipment, and office and vehicle operation.

- If the State does not mandate energy standards for residential buildings which are suited to County climate regions and which would result in substantial conservation of electricity as well as natural gas (see Alternative C, Section V-C), by January 1978, the County should develop its own building energy code to achieve greater conservation benefits than are provided by State Residential Standards of 1975.

VIII. EVALUATING ENERGY USE AND CONSERVATION IN PROJECTS

This section presents a way to make the energy use calculations required in Environmental Impact Reports and to identify the conservation opportunities associated with the several stages in project development. The section is in three parts:

A. Basic tables from which BTUs may be derived. Section VIII contains summary tables, largely derived from Volume II, Energy Study report, Guidelines for New Development in Contra Costa County, available from the County Planning Department. Volume II contains many detailed analysis tables, and details the derivation of the tables given here.

B. Method and calculation sheet for determining energy implications of a non-development urbanization project. An Area General Plan in the County is used as an example.

C. Checklist of Energy Use and Conservation Opportunities. This is designed for evaluation of a development project, specifically a single family detached residential major subdivision.

Part A consists of Tables VIII-1 through VIII-12. Parts B and C are adaptable to other areas, climates, and types of projects. The calculations in B can be made by virtually anyone with a calculator and appropriate energy use tables.

The information presented in Table VIII-1 must be used carefully for several reasons. First the information is based on 1967 conditions. Although the cost figures have been updated, changes in technology may have altered the energy used in production of certain goods. Second, the information reflects nationwide averages. Energy costs of commodities can vary widely from region to region; for example, shipping California-grown foods to the East Coast. Third, the values in the table refer to producers' costs; thus, the cost of producing goods must be added to the retailer's cost to "produce" retail services in selling the product for total energy from raw material to consumer. Finally, energy used should be adjusted to reflect rising land cost or other factors which increase dollar costs but not energy use.

TABLE VIII-1: ENERGY COST OF SELECTED GOODS AND SERVICES
(BTU/DOLLAR UNIT OF FINAL OUTPUT)

INDUSTRY	BTU/DOLLAR 1967[1]	BTU/DOLLAR 1975	PRICE INDEX % INCREASE 1967—1975[5]	SOURCE
Vegetables, Miscellaneous Crops	42,738	24,000	79	7
New Construction, Residential	55,093	28,000	94	4
New Construction, Nonresidential	67,206	36,000	88	4
New Construction, Public Utility	79,610	36,000	88	4
New Construction, Highway	117,400	51,000	130	6
New Construction, Other	86,662	41,000	112	3, 5
Maintenance Construction, Residential	50,043	26,000	91	2
Maintenance Construction, Other	57, 108	30,000	88	4
Fertilizers	173,931	101,000	72	7
Paving	562,526	236,000	138	6
Asphalt	482,118	210,000	130	6
Cement	480,161	197,000	144	6
Clay Products	259,949	172,000	51	7
Concrete Products	142,050	64,000	123	6
Ready-Mix Concrete	180,661	31,000	123	6
Plumbing Fittings	74,907	47,000	59	7

TABLE VIII-1 (Continued)

Pipe	74,272	36,000	109	7
Construction Machinery	68,040	36,000	91	7
Transformers	73,545	53,000	40	7
Switchgear	46,444	28,000	65	7
Electrical Equipment	63,808	45,000	43	7
Communications	17,405	14,000	26	2
Water, Sanitary Service	108,371	62,000	74	2
Retail Trade	35,413	23,000	52	2
Misc. Business Service	26,996	18,000	54	2
Misc. Professional Service	24,991	16,000	54	2

SOURCES

1. Herendeen and Bullard, Energy Cost of Commerce Goods, 1963 and 1967, Center for Advanced Computation, University of Illinois at Urbana-Champaign, Document No. 140, November 1974.
2. United States Department of Labor, Bureau of Labor Statistics, Consumer Price Index, October, 1975.
3. Lee Saylor, Inc., Construction Cost Newsletter, October, 1975.
4. "Building Costs," Architectural Record, McGraw-Hill, Inc., October, 1975, and February, 1968. (Tables compiled by Dodge Building Cost Services, McGraw-Hill Information Systems Company.)
5. "3rd Quarter Cost Roundup," Engineering News Record, McGraw-Hill, Inc., September 18, 1975, p. 64. (Building Cost and Price Indexes from Engineering News Record, U. S. Commerce Department, Bu Rec, Dodge Building Cost, Factory Mutual Industrial Buildings, Means Construction Costs, etc.)
6. California Highway Construction Cost Index, CALTRANS, 16 October 1975.
7. Monthly Labor Review, Department of Commerce, Bureau of Labor Statistics, November 1975, (Wholesale Price Index and Price Indexes for the Output of selected SIC Industries).

TABLE VIII-2: ENERGY REQUIREMENTS FOR PRODUCTION OF FUELS AND ELECTRICITY[1]

Cagegory	Energy Input (BTU input per BTU of product)
Mined Coal	1.01
Refined Petroleum Products	1.21
Electric Power[2]	3.80 (3.226)
Natural Gas	1.10

[1]Herendeen, Energy Costs of Commerce Goods, 1963 and 1967.

[2]PG&E uses a figure of 3.226 BTU input for an output of 1.0 BTU of delivered electrical energy.

TABLE VIII-3: NEIGHBORHOOD HOUSING TYPES

	A Single-Family Conventional	B Single-Family Clustered	C Townhouse Clustered	D Walk-Up Apartment	E High-Rise Apartment	F Housing Mix (20% Each A-E)
Dwelling Units	1,000	1,000	1,000	1,000	1,000	1,000
Average Floor Area Per Unit (square foot)	1,600	1,600	1,200	1,000	900	1,260
Total Population	3,520	3,520	2,220	2,220	2,825	3,300
Persons per Unit	3.5	3.5	3.3	3.3	2.8	3.3
School Children	1,300	1,300	1,100	1,100	300	1,100
Total Acreage	500	400	300	200	100	300
Residential	330	200	100	66	33	145
Open Space/Recreation	45	90	90	73	32	66
Schools	29	29	26	26	15	26
Churches	5	5	5	5	5	5
Streets and Roads	75	60	45	30	15	45
Vacant	16	16	34	0	0	13
Residential Density						
Units per Gross Acre	2	2.5	3.3	5	10	3.3
Units per Net Residential Acre	3	5.0	10.0	15	30	6.9

Source: The Costs of Sprawl,

TABLE VIII-4: INITIAL ENERGY FOR SITE CONSTRUCTION

STREETS AND ROADS

BTU's x 1000	A Single-Family Conventional	B Single-Family Clustered	C Townhouse Clustered	D Walk-Up Apartment	E High-Rise Apartment	F Housing Mix (20% Each A-E)
Arterial Streets	31,920	29,260	26,600	19,684	12,768	23,940
Collector Streets	18,613	45,735	35,896	29,693	16,382	27,228
Minor Streets	79,101	37,026	26,590	11,965	4,520	36,994
Seeding	435	319	194	126	168	209
Subtotal	130,069	112,340	89,280	61,468	33,738	88,371
Profit, Overhead, Engineering	12,446	10,742	8,535	5,874	3,229	8,438
Totals	142,515	123,082	97,815	67,342	36,967	96,809
Operation and Maintenance Per Year	1,990	1,480	919	561	306	1,021

STORM DRAINAGE

BTU's x 1000	A Single-Family Conventional	B Single-Family Clustered	C Townhouse Clustered	D Walk-Up Apartment	E High-Rise Apartment	F Housing Mix (20% Each A-E)
Pipeline[1]	54,565	37,238	25,784	17,786	6,956	28,466
Profit, Overhead, Engineering[2]	4,170	2,846	1,970	1,359	532	2,175
Totals	58,735	40,084	27,754	19,145	7,488	30,641

TABLE VIII-4 (Continued)

SANITARY SEWERAGE

	A Single-Family Conventional	B Single-Family Clustered	C Townhouse Clustered	D Walk-Up Apartment	E High-Rise Apartment	F Housing Mix (20% Each A-E)
Construction Costs (BTU's x 1000)						
Pipeline	46,435	30,785	19,606	11,698	6,927	21,928
Manholes	7,847	5,188	3,313	1,962	1,177	3,706
Subtotal	54,282	35,973	22,919	13,660	8,104	25,634
Profit, Overhead, Engineering	4,243	2,812	1,791	1,068	633	2,003
Totals	58,525	38,785	24,710	14,728	8,737	27,637
Operating and Maintenance Costs BTU's x 1000 (per year)						
Pipeline	329	218	139	83	49	152
Treatment	1,265	1,265	1,196	1,196	1,013	1,196
Other	752	1,504	1,422	1,422	1,204	1,422
Totals	2,346	2,987	2,757	2,701	2,266	2,770

WATER SUPPLY

	A Single-Family Conventional	B Single-Family Clustered	C Townhouse Clustered	D Walk-Up Clustered	E High-Rise Clustered	F Housing Mix (20% Each A-E)
BTU's x 1000 (1975)						
Pipeline	94,909	62,920	40,072	26,285	16,228	52,088
Hydrants	3,699	2,466	2,227	1,850	1,850	2,501
Valves	4	2	2	1	1	2
Subtotal	98,612	65,388	42,301	28,136	18,079	54,591
Overhead, Profit, Engineering	7,708	5,111	3,306	2,199	1,413	4,267
Totals	106,320	70,499	45,607	30,335	19,492	58,858
Operating and Maintenance Inputs Per Year BTU's x 1000	2,319	2,319	2,194	2,194	1,861	2,194

TABLE VIII-5: SITE CONSTRUCTION ENERGY PER RESIDENTIAL UNIT

BTU's x 100,000	A Single-Family Conventional	B Single-Family Clustered	C Townhouse Clustered	D Walk-Up Apartment	E High-Rise Apartment	F Housing Mix (20% Each A-E)
Streets and Roads	1,425	1,231	978	673	370	968
Storm Drainage	590	400	280	190	70	310
Sanitary Sewerage	590	390	250	150	90	280
Water Supply	1,060	700	460	300	190	590
Electrical Service	70	50	30	20	10	30
Gas Service	50	40	20	20	10	30
Telephone Service	40	30	30	10	10	20
Total	3,825	2,841	2,048	1,363	750	2,228

TABLE VIII-6: SITE CONSTRUCTION ENERGY PER LINEAR FOOT OF STREET

	A Single-Family Conventional	B Single-Family Clustered	C Townhouse Clustered	D Walk-Up Apartment	E High-Rise Apartment	F Housing Mix (20% Each A-E)
Linear Feet of Street Per Residential Unit	60	44	28	15	7	28
BTU's per Linear Foot x 100,000						
Streets and Roads	23.75	27.97	34.93	44.89	52.81	34.57
Storm Drainage	9.79	9.11	9.91	12.76	10.70	10.94
Sanitary Sewerage	9.75	8.81	8.82	9.82	12.48	9.87
Water Supply	16.43	14.86	15.11	18.76	25.83	19.50
Electrical Service	1.24	1.05	1.06	1.17	1.60	1.10
Gas Service	.91	.82	.82	1.23	1.50	1.01
Telephone	.69	.76	.99	.93	.79	.87
Totals	62.56	63.38	71.64	89.56	105.71	77.86

TABLE VIII-7: BUILDING CONSTRUCTION ENERGY PER RESIDENTIAL UNIT

	A Single-Family Conventional	B Single-Family Clustered	C Townhouse Clustered	D Walk-Up Apartment	E High-Rise Apartment	F Housing Mix (20% Each A-E)
Costs						
Average Floor Area Per Unit (square feet)	2,100[1]	1,600[2]	1,200[2]	1,000[2]	900[2]	1,260[2]
Cost Per Square Foot	24.63[3]	24.63[4]	22.17[4]	21.69[5]	38.18[5]	26.26
Total Cost Per Unit	52,723	39,408	26,604	21,690	34,362	33,087
BTU's x 1000 Energy Input Per Square Foot[6]	691	691	621	607	1,069	735
BTU's x 1000 Energy Input Per Unit	1,451,100	1,105,600	745,200	607,000	962,100	926,100

Sources:

[1] Contra Costa County Building Department.
[2] Real Estate Research Institute, The Costs of Sprawl. (Because development in unincorporated areas of Contra Costa County is predominantly single family detached, there is insufficient data available to establish averages for Types B, C, D and E.)
[3] Bank of America, Cost Study, Standard Quality Single Family Residence, San Francisco: Bank of America Appraisal Department, January, 1976.
[4] Cotton, Jack, Centex Homes Construction Department, Foster City, California.
[5] Real Estate Research Council of Northern California, San Francisco.
[6] Table 1.1, Energy Cost of Selected Goods and Services.

TABLE VIII-8: PROJECTED ANNUAL RESIDENTIAL ENERGY USE

	Dwelling Unit Type	Electricity KWH	Electricity in BTU's x 1000	Natural Gas in Therms	Natural Gas in BTU's x 1000	Total BTU's x 1000
1.	Single Family Detached (pre-1975)	9975	30,014	2530	253,000	287,000
2.	Single Family Detached (1975-1977)	9900	33,800	2100	205,000	238,800
3.	Single Family Detached (post-1977)	7575	25,800	1550	155,000	180,800
4.	Attached (80% of Unincorporated average)	5386	18,368	1014	101,400	119,808
5.	Apartment (60% of Unincorporated average)	5050	13,800	760	76,000	89,800

Source: PG&E and Contra Costa County Planning Department

TABLE VIII-9: OPERATION AND MAINTENANCE OF SITE IMPROVEMENTS: ENERGY PER RESIDENTIAL UNIT PER YEAR

BTU x 100,000	A Single-Family Conventional	B Single-Family Clustered	C Townhouse Clustered	D Walk-Up Apartment	E High-Rise Apartment	F Housing Mix (20% Each A-E)
Streets and Roads	19.90	14.80	9.19	5.61	3.06	10.21
Storm Drainage[1]	-	-	-	-	-	-
Sanitary Sewerage	23.46	29.87	27.57	27.01	22.66	27.70
Water Supply	23.19	23.19	21.94	21.94	18.61	21.94
Totals (Per Year)	66.55	67.85	58.70	54.56	44.33	59.85
Totals (20-Year)	1,331	1,357	1,174	1,091	886	1,197

Notes:

[1]Included in Streets and Roads.

TABLE VIII-10: LONG-TERM ENERGY USE FOR NON-RESIDENTIAL BUILDING OPERATIONS, 20 YEARS

BUILDING TYPE	BTUx100,000/SF/YEAR	BTUx100,000/SF/20-YEAR
Office Building - High Rise[1]	1.58	31.58
Office Building - Low Rise[1]	1.41	28.24
School[1]	0.87	17.34
Retail Structure[1]	4.19	83.80
Medical Facility - Privately-Owned[1]	3.00	60.02
Nursing Home[2]	4.83	96.55
Library[2]	2.65	53.09
Auditorium[2]	1.68	33.53
Indoor Swimming Pools[3]	9.16	183.26

[1]Source: Hugh Carter Engineering Corporation, Non-Residential Energy Conservation Standards, Title 24, Economic and Energy Effectiveness Study (Sacramento, CA: State of California Energy Resources Conservation and Development Commission, 5 November 1975). These projections were made in a study to determine the effect on energy consumption of the proposed California Prescriptive Standards for non-residential building use. An average of the San Jose projections was used in each case and multiplied by the primary energy ratio of 1.1 for gas and 3.226 for electricity. For reasons that were not apparent, the systems simulated in the study appeared to be more oriented toward electrical heating than what conventional practice would indicate. Perhaps the questionable long-term availability of natural gas was a factor in choosing electrical heating systems.

[2]Source: PGA Engineers, Incorporated, Florida Energy Conservation Manual (Tallahassee: State of Florida Department of General Services, March 1975). These projections are an average of the performance standards for each building type in eight different climatic areas of Florida. (Performance criteria are relatively unrelated to climate and therefore have applicability in California.) All systems are entirely electric and the site energy consumption has been multiplied by a primary energy ratio of 3.226.

[3]Source: Interactive Resources, Inc., Proposal Submitted to Energy Research and Development Administration by City of Richmond, California, for Richmond Municipal Natatorium Solar/Gas Integrated Energy System Demonstration Project (Richmond: Interactive Resources, Inc., 26 November 1975). This projection is for an all-gas system with a primary energy ratio of 1.1. The consumption ratio is per square foot of pool surface area.

TABLE VIII-11: PARK ENERGY USE

Type of Park & Facilities	Annual Energy Use BTUX1000	Use per Acre Per Year BTUX1000
Neighborhood Park - 4.5 Acres	22,847	5,077
Turfed Field		
Baseball Diamond		
Surfaced Court		
Barbeque and Playground		
Bathroom Facilities		
Community Park - 17 Acres	4,392,298	258,370
Lighted Ballpark	1,620	
Swim Complex	1,901,031	
Senior Center	680,094	
Recreation Center	1,373,274	
Office	213,900	
General Lighting	11,066	
General Gas Use	209,700	
Maintenance Shop	1,613	
Community Park less Swim Complex	2,491,267	146,545

Source: City of Pleasant Hill Park and Recreation District

TABLE VIII-12: COMPARATIVE ENERGY USE FOR LANDSCAPING IN LIVERMORE, CALIFORNIA (20-year period, per 1000 sq. ft.)

Item	BTU X 1000
Bluegrass Lawn	31,600
Irrigated Shrubbery	24,400
Irrigated Ground Cover	20,000
Native Drought-resistant Ground Cover	4,800

Source: Dahlin, the Greedy Lawn

B. EVALUATING ENERGY USE IN URBANIZATION - NON-DEVELOPMENT PROJECT ANALYSIS

The step-by-step method and calculations are adaptable to a development project. An area General Plan was selected as the example because of the difficulties presented in determining energy for general plans and re-zonings where the actual ultimate development is not known.

In addition to uncertainties in presently available information, there are great uncertainties in evaluating community development based on any general plan. The land area designations for all uses are often more extensive than are expected to develop during the effective period of the plan, so predicting long-term needs depends upon both informed judgment regarding growth rates and the time-frame of the evaluation.

This example is subject to the uncertainties noted above to a great degree since it is an evaluation of the general plan for an area which is planned to accommodate a continuing rapid rate of urbanization, with all the energy needs of a suburban bedroom community located at some distance from centers of operation of County facilities and services. Yet there are indications from the last two years, including a fall in the growth rate, planned and approved projects dropped rather than built, inflation in the cost of housing, unresolved air and water quality problems, and limited public works budgets, that make it impossible to evaluate the 1980s with the sense of certainty we had in evaluating the 1970s. The example attempts to quantify the energy implications of an area general plan, thus a development time factor has not been introduced. Rather, the plan is treated as if built out at some point in time. Twenty years is used as the long-term energy use period.

The Land Use Map of an area general plan only tells part of the story. Estimates of types and densities of development, constraints, ideals for community form, heights of buildings, road standards, and so forth, should be interpreted from the text. In order to evaluate the energy implications of the plan, the following steps were taken to derive units such as linear feet and dwelling units (DU) to which an amount of energy could be assigned.

The steps are described below and displayed in Table VIII-13:

1. The various land use categories on the plan map were measured by planimeter and converted to acres in Column A.

2. Acreage developed in each land use category (Column B) were measured in acres and subtracted from Column A to yield Gross Acreage Proposed for Urbanization (Column C).

3. Since not all of the land designated for each use will actually be developed in that use, it is necessary to apply a multiplier to provide Net Acres (Column D). For Single Family Detached land use areas, the multiplier is 0.7. The remaining 30% of the land is assumed to be in streets and roads (25%), and public facilities and services (5%). This represents the approximate percentages in existing residential areas in the general plan area. Steps 1, 2, and 3 yield Net Acres (Column E).

4. Using Net Acres, an additional multiplier is applied, representing average DU per acre for residential land use categories or land actually covered by buildings for non-residential land uses. The multiplier is obtained by observation of existing similar development in the area. Aerial photos are helpful in this if written information is not available (Column F).

5. The last step consists of multiplying Net Acres by Average DU per acre to yield Total DU, or multiplying Net Acres by Land Coverage to yield gross square feet of floor (gsf) for non-residential land uses (Column G). Now we have a DU count and a gsf of floor which can be multiplied by the appropriate BTUs from the Tables and then be added up for total energy use in the general plan area, as shown in the calculation sheet, Table VIII-15.

The outline of the procedure is as follows:

I. Initial Construction Energy Use

   A. Site Construction
   B. Building Construction
      1. Residential
      2. Non-Residential

   Total Construction Energy Use

II. Long-Term Energy Use

   A. Site Maintenance
   B. Energy Use in Buildings
      1. Residential
      2. Non-Residential

   Total Long-Term Energy Use

I plus II equals total energy use in project.

TABLE VIII-13: URBANIZATION: AREA GENERAL PLAN

	A Acreage in General Plan	B Acreage Developed	C Gross Acreage Acreage Proposed For Urbanization	D Multiplier to Derive Net Acres	E Net Acres	F Average DU/Acre or Land Coverage	G Total DU or Gross Square Feet of Floor
Single Family Detached DU	16,357	3,958	12,399	.7	8,680	3.5 DU	30,380 DU
Multiple Residential DU	666	48	618	.7	433	10.	4,330 DU
Commercial-Office	738	192	546	.75	410	.35 L.C.	6,250,860 Gsf
Industry	838	111	727	.8	582	.20 L.C.	5,070,384 Gsf
Public & Semi-Public	541	390	151	.8	120	.1 L.C.	522,120 Gsf
Parks & Recreation	300	50	250	.8	200	.001 L.C.	43,560 Gsf

TABLE VIII-14: STREET AND UTILITY LINE* LENGTHS

LAND USE	LINEAR FEET OF STREETS AND UTILITY LINES
Single Family Detached	3,375,900
Multiple Residential	168,700
Commercial - Office	94,960
Industry	43,560
Public and Service-Public	32,670
Parks & Recreation	54,450
Total	3,770,240

Street lengths are determined as follows:

1. Gross Acreaged Proposed for Urbanization (Table VIII-13, Column C) multiplied by percent of land expected to be in streets and roads = acres in streets and roads. For Single Family Detached, the example uses 25%.

2. Acres in streets and roads multiplied by 43,560 (square feet per acre) equals square feet in streets and roads, divided by average width of streets, equals linear feet of streets and roads.

Sample, Single Family Detached Land Use Area

1. 12,399 X .25 = 3,100 acres in streets and roads.

2. 3,100 X 43,560 = 135,036,000 $ft.^2 \div 40'$ = 3,375,900 linear feet of streets and roads.

*Utility lines are assumed to be the same length as streets and roads.

TABLE VIII-15: ENERGY USE IN URBANIZATION: CALCULATION SHEET

Item	Description & Source	Calculations
I. Initial Energy Use		
A. Site Construction	Lengths - Table VIII-14 Energy - Table VIII-6	
Streets & Roads Utility Lines	Item B chosen as closest to combined types of development proposed in General Plan	3,770,240 linear feet X 6,338,000 BTU/ft. 23,895,781,120,000 BTU
	Total, Site Construction	23.90 Trillion BTU
B. Building Construction		
1. Residential		
a. Single Family Detached	Number DU from Table VIII-13 Energy from Table VIII- 7	30,380 du X 1,451,100,000 BTU/DU 44,084,418,000,000,000 BTU
		440.84 Trillion BTU
b. Multiple	Number DU from Table VIII-13 Energy from Table VIII- 7	4,330 X 745,200,000 BTU/DU 3,226,716,000,000 BTU
		3.27 Trillion BTU
Total, Residential Building Construction		444.11 Trillion BTU

Table VIII-15.(Continued)

Item	Description & Source	Calculations
2. Non-Residential	Gsf from Table VIII-13 Construction energy not known. Figure used in Single Family divided by 1800 to derive a gross square foot (gsf) energy use figure.	
a. Commercial-Office		6,250,860 Gsf X 808,167 BTU/ft.^{2} 5,039,237,053,620 BTU 5.04 Trillion BTU
b. Industry		5,070,354 Gsf X 808,167 BTU/ft.^{2} 4,087,576,258,128 BTU 4.09 Trillion BTU
c. Public & Semi-Public		522,120 Gsf X 806,167 BTU/ft.^{2} 420,915,914,040 BTU .42 Trillion BTU
d. Parks & Recreation	Construction energy not known. Figure used is 25% of figure used for Non-Residential	43,560 Gsf X 201,542 BTU/ft.^{2} 8,779,169,520 BTU .009 Trillion BTU
Total, Non-Residential Building Construction		46.37 Trillion BTU
Total - All Construction		514.38 Trillion BTU

Table VIII-15 (Continued)

Item	Description & Source	Calculations
II. Long-Term Energy Use		
A. Site Maintenance	Table VIII-9, Column B selected as closest to overall development proposed in General Plan	3,770,340 Linear Feet X 6,785,000 BTU/Year X 20 Years 135,700,000 BTU .14 Trillion BTU
B. Energy Use in Buildings		
1. Residential		
a. Single Family Detached	Table VIII-8	30,380 DU 180,800,000 BTU/Yr. 5,492,704,000,000 BTU/Yr. X 20 Years 109,854,080,000,000 BTU 109.85 Trillion BTU
b. Multiple	Table VIII-8	4,330 DU 119,800,000 BTU Yr. 518,734,000,000 BTU/Yr. X 20 Years 10,374,680,000,000 BTU 10.37 Trillion BTU
Total Residential O&M		120.22 Trillion BTU
2. Non-Residential		
a. Commercial-Office	Gsf from Table VIII-13 Energy use from Table VIII-10 - Figure used is average of Low Rise Office and Retail	6,250,860 Gsf X 85,490 BTU/Gsf 5,347,473,021,400 BTU/Yr. X 20 Years 106,949,460,000,000 BTU 106.95 Trillion BTU

Table VIII-15 (Concluded)

Item	Description & Source	Calculations
b. Industry	Gsf from Table VIII-13 Energy Use from Table VIII-10 Figure used is high range for Medical Research, considered closest to light or "clean" industry	5,070,384 Gsf X 301,320 BTU/Gsf 1,527,808,106,880 BTU X 20 Years 30,556,160,000,000 Gsf 30.56 Trillion BTU
c. Public & Semi-Public	Gsf from Table VIII-13 Energy use from Table VIII-10 Figure used is schools, considered closest to all public and semi-public buildings	522,120 Gsf X 37,140 BTU/Gsf 19,391,536,800 BTU/Yr. X 20 Years 387,830,736,000 BTU .39 Trillion BTU
d. Parks & Recreation	Number and types of Parks from Recreation element of general plan. Energy use from Table VIII-11	
i. 20 Neighborhood Parks		5,077,000 BTU Yr. X 20 Years 2,030,800,000 BTU .002 Trillion BTU
ii. 8 Community Parks 2 With Swimming Pools 6 Without Swimming Pools		8,784,596,000 BTU/Yr. 14,947,602,000 BTU/Yr. 23,732,198,000 BTU/Yr. X 20 Years 654,643,960,000 BTU .65 Trillion BTU
Total, Non-Residential O&M		138.55 Trillion BTU
Total O&M		258.91 Trillion BTU
Grand Total, Construction & O&M		773.19 Trillion BTU

To give a feeling for the magnitude of the total, it is equivalent to 133,308,621 barrels of oil.

C. CHECKLIST OF ENERGY USE FACTORS AND CONSERVATION OPPORTUNITIES

The Outline is ordered in a way which appears practical for project energy inventory in the EIR. Conservation Opportunities are mitigation measures related to the aspects of project analysis delineated in the Outline. Emphasis is on conservation in project design and the building envelope, since these items are more impacted by Planning Agency review procedures than are items such as high EER refrigerators. Many detailed lists of interior energy-saving features and practices are available elsewhere.

TABLE VIII-16: ENERGY USE FACTORS AND CONSERVATION OPPORTUNITIES

A. Outline

I. Locational Factors (Transportation energy and transmission line losses)
II. Physical Factors (Climate, wind, slope aspect)
III. Project Design (Lot and street layout, utilities, and drainage layout)
IV. Site Construction (Materials and practices)
V. Building Design (Related to physical factors)
VI. Building Construction (Materials and practices)
VII. Mechanical Systems and Appliances (Building interior systems)
VIII. Landscaping (Related to physical factors)
IX. Operating and Maintenance (Exterior and interior of project buildings)
X. Co-Uses (Recreation, facilities, utilities)

B. Conservation Opportunities

1. Cluster or zero lot line
2. Solar orientation of lots
3. Solar orientation of buildings
4. Re-design or re-locate project
5. Maximum glazing on south
6. Avoid west glazing
7. Shade glazing in summer, south and west
8. Attic ventilation
9. Vestibule entrance
10. Insulate against heat gain and loss
11. Minimum paved area
12. Minimum length utility and drainage lines
13. Avoid paving adjacent to building
14. Narrow roads
15. Minimum grading
16. Natural ventilation and light
17. Solar space heating and cooling
18. Solar water heating
19. Minimum hours of lighting
20. High efficiency lamps
21. Hike and bike trails
22. Wind break
23. Shade west walls
24. Deciduous shade trees
25. Climate-adapted plants
26. Neighborhood pool and other recreation
27. High efficiency mechanical systems and appliances
28. Avoid gadgets (gas lamps)
29. On-site wastewater treatment
30. Street shade trees
31. Energy-efficient vehicles and machines
32. Avoid shift from gas to electricity
33. Provide public transportation
34. Energy-efficient materials, i.e., wood vs. aluminum

TABLE VIII-17: ENERGY USE FACTORS AND CONSERVATION OPPORTUNITIES

Checklist

Energy Use Factor	Energy Use	Long-Term Use	Conservation Opportunity
I. LOCATIONAL FACTORS			
A. Proximity to energy sources			
1. Electricity transmission	Transmission Line Losses	X	4, 32
2. Transport of vehicle fuels and construction materials	Pipe line construction, Vehicle fuels	X	4, 33
B. Transportation			
1. Proximity to: Schools Recreation Shopping Employment Solid waste site Public safety services	Vehicle fuels	X	4, 33
2. Availability of Public Transportation to: Schools Recreation Shopping Employment	Vehicle Fuels	X	33
3. Availability of non-motorized circulation to: Schools Recreation Shopping Employment	Human energy	X	21

APPENDIX A: NON-RESIDENTIAL ENERGY USE IN CONTRA COSTA COUNTY

The information in this Appendix pertains to energy use in Contra Costa County for agriculture, commerce, industry, local parks, solid waste, waste water treatment, and street lighting. Information was provided by PG&E, facility managment, and for agriculture, by the sources cited. A revealing part of the research for this information was repeated statements that companies and facilities management expected to have more precise and usable energy figures in a year or two. While compiling non-residential energy use figures, data was limited by lack of data availability now, all large energy users appear to be entering an era of energy-awareness. By 1978 it should be possible to pull together material which will make a more satisfactory desk reference for EIR writers and reviewers than this Appendix. All of this information, except for agriculture, is preliminary and requires updating as data becomes available.

1. Agricultural Energy Use

The agriculture and food processing industry uses electricity and other fossil fuel energy for transportation, equipment and machinery, pumping, fertilizers and other chemical products, and food processing.

Table A-1 gives a breakdown of agricultural energy use in California, and Table A-2 gives acreages in the most widely grown areas in the County plus average yields. From these tables energy use can be determined on an acreage or yield basis for the given crops.

Energy use for chemical fertilizers has been examined as a separate item (Tables A-3 and A-4) because conservation has occurred in chemical use; a reduction of 30% to 35% in the last two years, and shifts to alternative fertilizers including composts and manures are expected to result in further significant conservation in this area. Additional conservation is anticipated in food processing (solar water heating and solar drying), but these are not yet in evidence in the County.

2. Commercial and Industrial Energy Use

The commercial and industrial energy demand data for Contra Costa County reveal total consumption of nearly 3.8 billion KWHRS in 1975. This total represents a 9.6% increase over 1970. The largest category of use within commercial and industrial energy demand includes large industrial firms such as oil refineries and chemical plants. The 58 PG&E electrical customers in this category account for 73.3% of commercial and industrial KWHR demand.

The large industrial category is also the most rapidly growing within the commercial and insustrial sector. Its 1970-1975 growth was 4.3%, contrasted with 3.2% for small commercial firms and 2.6% for medium-sized commercial firms. The size distinctions among energy customers are made by PG&E on the basis of energy demand (generating capacity) and consumption (actual use). Growth 1970-1975 is shown in Table A-5.

TABLE A-1

ENERGY INPUTS PER TON OF YIELD
BTU'S x 1000

Field Crops	Crop Establishment	Cultural Practices	Harvesting	Transportation	Processing	Fertilizers	Irrigation	Other	Total BTU per Ton	Total BTU per Acre*	Total BTU's per Ton of Yield Less BTU's for Fertilizers
Barley	502	1	260	125	117	668	---	227	1,900	2,436	1,232
Corn, feed	779	112	160	160	119	1,313	1,541	237	4,480	11,847	
Hay, alfalfa	97	20	153	83	---	112	725	129	1,320	7,521	1,208
Sorghum	462	109	177	174	117	1,386	2,068	223	4,716	9,385	
Sugar Beets	61	33	31	107	2,715	201	171	59	3,377	81,576	3,176
Wheat, feed	509	1	263	381	117	677	---	221	2,169	2,754	
Vegetables											
Asparagus											
Fresh	395	1,275	1,323	91	109	1,776	2,650	1,734	9,352	14,589	
Canned	395	1,275	1,323	608	7,295	1,776	2,650	1,734	17,054	26,605	
Lettuce	199	92	135	109	107	497	365	389	1,892	21,414	1,395
Onions	208	129	26	91	135	431	253	275	1,548	25,324	
Tomatoes											
Fresh	117	60	12	106	135	229	187	194	1,040	23,036	
Canned	117	60	152	249	3,089	229	187	194	4,276	94,712	4,047
Corn, sweet	436	105	160	192	1,741	1,313	1,541	235	5,723		
Fruits & Nuts											
Almonds	567	3,061	1,722	316	2,209	5,018	5,991	9,224	28,108	19,395	23,100
Apricots	66	862	233	115	134	616	800	506	3,332	17,224	
Grapes	26	343	117	78	130	226	604	786	2,312	15,812	
Peaches	57	448	102	111	130	346	344	328	1,865	22,422	
Pears	41	556	116	115	130	498	496	1,849	3,801	31,699	
Prunes	150	1,914	1,145	358	5,276	768	917	3,519	14,040	22,324	
Walnuts	671	2,961	1,245	503	19,661	7,386	5,512	4,677	42,615	13,961	35,228

*BTU's per ton/Statewide average of tons per acre, 1968-1972.

SOURCE: California Dept. of Food and Agriculture, UC Davis, Energy Requirements for Agriculture in California, January 1974.

TABLE A-2

AGRICULTURAL PRODUCTION
CONTRA COSTA COUNTY, 1975

Field Crop	Acres 1975	Tons for All Acres 1975
Barley	6,440	10,000
Corn, feed	5,770	24,200
Hay, alfalfa	1,060	7,410
Sorghum	1,560	3,570
Sugar Beets	3,800	110,000
Wheat, feed	3,700	9,140
Vegetables		
Asparagus	1,280	1,072
Lettuce	1,220	17,100
Onions	15	233
Tomatoes	5,121	137,412
Corn, sweet	469	2,620
Cabbage	102	1,770
Fruits & Nuts		
Almonds	3,708	1,080
Apricots	1,695	6,972
Cherries	286	521
Grapes	1,051	3,610
Peaches	92	218
Pears	352	2,314
Prunes	40	86
Walnuts	5,886	5,760
TOTAL	43,647	

*Agricultural Report, 1975, Contra Costa County Department of Agriculture.

TABLE A-3

ENERGY REQUIRED TO PRODUCE ONE TON
OF NUTRIENTS (BTU'S)*

	N (Nitrogen)	P_2O_5 (Phosphorous)
Natural Gas	51,128,000	439,000
Electricity	3,241,533	251,929
Diesel Fuel Oil	18,200	---
Gasoline	19,680	---
TOTAL	54,407,413	690,929

*Appendix C, "Energy Requirements for Agriculture in California", California Department of Food and Agriculture and Agricultural Engineering Department, University of California, Davis: January 1974.

TABLE A-4

NATURAL GAS CONSUMPTION IN THE PRODUCTION
OF FERTILIZER
AND RECOMMENDED RATE OF APPLICATION
BY CROP

Crop	Pounds of Nitrogen per Acre	Natural Gas/Acre (Therms)	BTU's Acre per Year
Barley	20	5.11	511,280
Corn	100	25.56	2,556,400
Hay, alfalfa	20	5.11	511,280
Sorghum	80	20.45	2,045,120
Sugar Beets	150	38.35	3,834,600
Wheat	20	5.11	511,280
Asparagus	100	25.56	2,536,400
Lettuce	200	51.13	5,112,800
Onions	250	63.91	6,391,000
Tomatoes	150	38.35	3,834,600
Almonds	150	28.35	3,834,600
Apricots	80	20.45	2,045,120
Grapes	40	10.23	1,022,560
Peaches	150	38.35	3,834,600
Pears	150	38.35	3,834,600
Prunes	75	19.17	1,917,300
Walnuts	200	51.13	5,112,800

Source: Table 87 "Recommended Crop Nutrition Rates" (minimum values contained in Table) Energy Requirement for Agriculture in California.

TABLE A-5

COMMERCIAL AND INDUSTRIAL ENERGY DEMAND IN

CONTRA COSTA COUNTY: 1970 & 1975

ENERGY DEMAND CUSTOMER	NUMBER OF CUSTOMERS		UNIT SALES (Millions of KWHRS)		PERCENT CHANGE
	1970	1975	1970	1975	1970-1975
Commercial					
Small	14,416	15,980	215.3	284.5	+3.2
Medium	1,278	1,269	574.4	720.9	+2.6
Large Industrial	58	65	2,649.0	2,763.7	+4.3
TOTALS	15,752	17,314	3,438.7	3,769.1	+9.6

Source: Economics and Statistics Division, Pacific Gas & Electric Company

Prepared By: Contra Costa County Planning Department

In the industrial sector, petroleum is the largest single type of industry in the County in energy use (2.25 billion KWHR in 1975) and also has the largest electricity use by individual company. The average per company consumption of 321.7 million KWHR per year is fifteen times greater than the next highest energy use type of industry, paper and allied products. See Table A-6.

Because of the magnitude of electricity use in the industrial sectors, the impacts of conservation in industry are significant for total electricity use in the County. The total of 396.3 million KWHR (Table A-6) is equivalent to approximately 1.3 trillion BTU's, or 248,650 barrels of oil. A conservation of 10%, reported in a Ford Foundation study to be possible without heavy capital expenditures, would make 40 million KWHR available for other uses, or enough to supply an industrial and commercial energy growth rate equivalent to the period 1970-1975, or equivalent to the electricity used in 5,700 residences. PG&E is active in encouraging energy conservation in industry. The Public Utilities Commission is establishing inverted rate structures which will add to the cost of non-residential electricity. Thus, with "utility bills" amounting to tens or hundreds of thousands of dollars a year, large consumers that are conservation oriented will be better able to absorb continued cost increases.

3. Public Facilities

In order to gain a concept of the magnitude of energy use in the County for public facilities and services, information was collected on public buildings, parks, water service, solid waste, sewage treatment and street lighting. An analysis of several County buildings was undertaken by the consultant on this study. Other information was provided by the facility or service management. The results were somewhat surprising. Although it was recognized that pumping water to higher pressure zones to service hill areas represents a significant use of energy beyond that required to provide water to the valley floors, the energy required to provide water to the County, regardless of elevation, had not been fully realized. On the other hand, the Centra Contra Costa County Sanitary District has been converting sewage to burnable gas to supply part of the treatment plant energy needs for over 20 years.

a. Parks

Neighborhood and community parks are provided by cities, park and recreation districts, and County service areas. A neighborhood and a community park in the Central County Pleasant Hill Park District were analyzed. Each of these is of a size and provides the types of activities recommended in the County Recreation and Parks Element of the General Plan, and each is representative of the kinds of neighborhood and community parks expected to be developed in the future by county park service areas and park districts. Regional and State parks are not included.

The neighborhood park, Rodgers-Smith Park, in the City of Pleasant Hill, consists of 4.5 acres and includes:

Turfed athletic field and free play area
One baseball diamond
Surfaced court area (baseball, tetherball and volleyball)
Barbecue facilities, shade structure, playground/tot lot
Bathroom facilities

TABLE A-6

ESTIMATED DISTRIBUTION OF KWHR ENERGY DEMAND AMONG

CONTRA COSTA COUNTY MANUFACTURING INDUSTRIES AND INDUSTRIAL FIRMS: 1975

	NUMBER OF FIRMS [1]	KWHR DEMAND (millions) (Estimate)	KWHR PER FIRM (millions)
Food & Kindred Products	5	40.5	8.1
Paper & Allied Products	8	171.2	21.4
Printing & Publishing	3	1.2	0.4
Chemicals	10	148.0	14.8
Petroleum	7	2,251.8	321.7
Stone, Glass & Clay	4	58.0	14.5
Primary Metal Products	6	37.5	6.3
Fabricated Metal Products	11	45.3	4.1
Electrical Machinery	4	5.6	1.4
Transportation	1	3.4	3.4
Other Manufacturing	6 [2]	1.2	0.2
TOTALS	65	2,763.7	396.3

[1] Firms employing 100 or more employees according to 1970 U.S. Census.

[2] Reflects SIC 38 Instruments, for which actual energy data was not available. Also included are three industrial customers which could not be classified by industry.

Source: 1970 U.S. Census of Population, County Business Patterns, Table 2; 1972 Census of Manufactures, "Fuels and Electric Energy Consumed," Special Report Series, C72(SR)-6.

Energy use is approximately 6700 kwh per year (22,847 BTU x 1000), or 5,077 BUT x 1000 per acre.

The Pleasant Hill Community Park consists of 17 acres and includes:

- Turfed athletic fields and areas for free play
- Two baseball diamonds (one field lighted)
- Baseball equipment shack
- One tot lot/playground
- Barbecue facilities
- District office and meeting room
- Maintenance building and yard
- Swim complex and accompanying building, including locker rooms, offices, meeting rooms and snack bar
- Field house for meetings and classes
- Bathroom facilities
- Senior Citizens Center

TABLE A-7

ANNUAL ENERGY USE, SELECTED PARKS AND POOLS

Facility	KWH	Therms	BTU x 1000
Community Parks			
Lighted ballpark	475		1,620
Swim Complex 187,000 gallon pool, 1875 sq. ft. used 9 mos.	3,968	18,875	1,901,031
Senior Center 2,400 sq. ft.	3,312	6,688	680,094
Community Recreation Center	5,359	13,550	1,373,247
Park District Office		2,139	213,900
General lighting	3,245		11,066
General gas use		2,097	209,700
Maintenance shop	473		1,613
TOTAL	16,832	43,349	4,392,298 = 258,370 BTU x 1000/acre

TABLE A-7 (Continued)

ANNUAL ENERGY USE, SELECTED PARKS AND POOLS

Facility	KWH	Therms	Total BTU x 1000	BTU Per Gallon	KWH/ Gal.	Therms Per Gallon
Comparison of Pools						
Community Park Pool 187,000 gallon pool, 1875 sq. ft. used 9 mos.	3,968	18,875	1,901,031	10,166	47.13	0.1
High School Pool 335,000 gallons 6130 sq. ft., used 12 mos.	7,936	29,445	2,971,556	8,870	42.21	0.09

The swim complex at the Pleasant Hill Community Park and the swimming pool facility at College Park High School, also in Pleasant Hill, were compared to determine if there is a standard rate of energy use for large pools used for 9 months a year. Until better information is available, the findings on this may be used to predict energy use in large pools. What appears to be a greater energy efficiency in the High School Pool is attributed to dressing rooms being excluded, whereas for the Community Park Pool, co-uses are included.

b. Municipal Water Supply

Municipal water supplies are provided by the Contra Costa County Water District and the East Bay Municipal Utility District. The CCCWD has approximately 38,000 service connections and serves over 150,000 persons. Electricity used for pumping and treatment is approximately 2,250 kwh per million gallons.

TABLE A-8

ENERGY USE IN MUNICIPAL WATER SUPPLY

Energy Use	Per Million Gallons KWH	Per Million Gallons BTU x 1000
Residential pumping	1,640	5,592
Contra Costa Canal	500	1,705
Water Treatment	116	396
TOTAL per MG	2,256	7,693
Million gallons pumped and treated per day = 22.5	507,600	1,730,916
*Gallons/day/service connection (38,000 services) = 590 gal/day	1.33	4.5
**Approximate gallons/day/household = 400	0.66/400 gals.	2.05

SOURCE: *Contra Costa County Water District.
**Contra Costa County Planning Department.

This information should be evaluated carefully before being used to predict water supply energy for any specific project. Information from the other water supply district, East Bay Municipal Utility District, was not available.

c. Solid Waste

Energy is used in solid waste disposal, primarily for transportation and on-site vehicles. Nationwide solid waste collection uses about 3.6 percent of all highway use of diesel fuel and approximately 1.6 percent of all truck gasoline used. Figures for Contra Costa County are not available.

Per capita rates of waste generation in the County ranges from 2.3 pounds per day (Crockett-Rodeo area) to 6.5 pounds per day (Pittsburg-Antioch area, probably including an industrial waste factor). The historic rate of increase in per capita solid waste has been 1 percent per year. An attitude of resource conservation may cause a decline in residential and commercial waste generation.

Today, trash and garbage are resources. The information below on the energy potential of wolid waste is from Contra Costa County Solid Waste Management Report, Metcalf & Eddy, 1975, and the Contra Costa County Sanitary District Facilities Plan, Brown & Caldwell, 1975.

These wastes are estimated to have a high heating value of 4,350 BTU per pound (8,700,000 BTU per ton, as compared to 8,500,000 BTU per barrel of crude oil) with an average 25 percent moisture content. Approximately 1,136 tons of solid waste are deposited daily at the ACME landfill site. The garbage and commercial-industrial wastes deposited daily at ACME have an estimated energy content of 7,099,200,000 BTU's. Actual net energy recovery is not known. It is planned to burn 63 percent of this material to generate electricity for the Central Sanitary District wastewater treatment plant, a process expected to be operational by 1980. A pilot plant operation to determine the feasibility of energy recovery from the remaining 37 percent is planned.

TABLE A-9

ENERGY POTENTIAL
OF RECYCLED MATERIALS

Material	BTU x 1000 Per Ton of Material
Aluminum	200,000
Ferrous metals	12,000
Glass	1,300

d. Sewage Treatment

The national average energy use for primary and secondary sewage treatment is 880 kwh per million gallons of wastewater treated. The five treatment facilities currently operating in western Contra Costa County use an average of 2,633 kwh per million gallons (8,978,530 BTU), or three times the national average, probably due in great part to higher treatment levels than the national average. The West County plants use about 106 kwh per capita per year, or 276 kwh per residential unit. Most West County wastewater is treated in the San Pablo and Richmond plants.

The Central Contra Costa County Sanitary District has been recovering methane gas for 20 years in a sufficient quantity to power the plant. The existing plant will be replaced by a facility for secondary treatment by 1980. Secondary treatment will require at least twice as much energy per volume of material processed. Until 1980 or 1982 the new plant will use natural gas or diesel fuel. The second phase construction plant will include solid waste and sewage sludge heat recovery for steam generators. The value of the electricity thus generated is estimated to be 2 to 3 million dollars annually, and may be in excess of that needed to run the plant.

e. Street Lighting

Contra Costa County's "standard level of service" for street lamps is 60% of the light level recommended in the Illuminating Engineering Standards (IES) for residential areas and 50% of the IES for commercial areas, achieved by wider spacing of poles. Poles are customarily spaced 250 feet apart rather than the recommended 1975 foot spacing. Data regarding street lighting in County Service Areas is given in Table A-11.

TABLE A-10

ENERGY USE FOR WASTEWATER TREATMENT

	KWH	Average Daily Flow Million Gallons Per Day	KWH: Per Capita Per Day	KWH: Per Capita Per Year	KWH: Per Housing Unit Per Day	KWH: Per Housing Unit Per Year
San Pablo*						
1974	6,932,760	6.6441	.2494	91.03	.6907	252.11
1975	6,298,000	6.9438	.2694	98.31	.7460	272.29
Richmond**						
1974	6,066,600	6.7825	.3156	115.18	.7839	286.11
1975	6,319,858	6.3650	.3259	118.97	.8096	295.51

* Includes wastewater treatment only.
** Includes wastewater treatment and pumpimg.

TABLE A-11 STREET LIGHTING IN COUNTY SERVICE AREAS, 1974

Community	2,500 Incan.	4,000 Incan.	6,000 Incan.	10,000 Incan.	7,500 M.V.	11,000 M.V.	21,000 M.V.	37,000 M.V.	Cost Per Mo.
	Type of Lamps - in lumens								
Kensington	6				286	7	70		$1,206.22
El Sobrante					1027	1	70		4,590.23
Mt. View & Pacheco					508	26	26		2,325.59
East County					606	7	2		2,468.18
Walnut Creek, Danville & Moraga					1160	129	8		5,214.50
Crockett, Rodeo & Port Costa		1			516		78		2,547.73
Rollingwood					86		14		430.39
San Ramon					526	120	6		2,589.27
Danville					108	8			382.11
North Richmond					115		9		521.24
Discovery Bay					8				25.40
Orinda Downs					25				100.63
Orinda Village					4	32	56		467.83
San Pablo							7	27	329.95
Bethel Island					6				24.15
Clayton					63	2			240.53
Treat Blvd.					2	2			17.52
Clyde		35							136.50
Orinda					7				22.73
TOTAL	6	36			5053	334	276	27	$23,640.65
Safety Lighting County General Fund									
Diablo District		1	6	2	32	26	84		176.11
Bay District				5	8	3	17		665.58
Bay Point						3			21.60
Joint State-County Safety Lights				2	12		91		(6 mos.) $2,413.26
Total by Size	6	37	6	9	5105	366	468	27	

TOTAL LIGHTS	6027
TOTAL ANNUAL COST (1974)	$298,867.80
TOTAL KWH (at $0.018/kwh) *	16,603,770 kwh
TOTAL BTU's *	56,618,855,300 BTU
PER LIGHT PER YEAR *	2,755 KWH
PER LIGHT PER YEAR *	9,394,202 BTU

Source: Contra Costa County Public Works Department.

*Estimates by Contra Costa County Planning Department.

APPENDIX B: METHOD OF DETERMINIG VALUES OF CONSERVATION PROGRAM

The method used to evaluate energy saved by two alternative conservation programs, summarized in Section V-D is as follows:

Alternative C - Anticipated State Residential Standards in 1977

1. 1975 - 1980

New residences built, 20,330.

- Number of homes retrofitted is 5% of 213,403 times 5 years, or (.05) (5) (213,403) = 53,350 homes

- Energy saved through retrofitting of 53,350 existing homes assuming a 37% reduction in energy consuption is:

$$= (5.335 \times 10^{4} \text{ homes}) \ (1.5 \times 10^{8} \text{ BTU's/home/year})(.37)$$
$$= 2.87 \times 10^{12} \text{ BTU's/year}$$

- Energy needed for new homes, assuming the majority to be in the 3 to 4 bedroom range and also benefitting from a 37% reduction in energy is:

$$= (2.033 \times 10^{4} \text{ homes}) \ (2.87 \times 10^{8} \text{ BTU's/home/year}) \ (.37)$$
$$= 2.16 \times 10^{12} \text{ BTU's/year}$$

Therefore, the amount of the conserved energy from retrofitted structures required to satisfy the needs of the new structures on a per year basis at the end of five years is:

$$\frac{2.16 \times 10^{12}}{2.87 \times 10^{12}} = 0.75 \text{ or } \underline{75\%}$$

2. 1980 - 1990

- Number of new homes built is 27,780

- Number of homes retrofitted is 106,700

- Energy saved through retrofitting of 106,700 existing houses assuming a 37% reduction in energy consumption is:

$$= (2.778 \times 10^{4} \text{ homes}) \ (1.456 \times 10^{8} \text{ BTU's/home/year}) \ (.37)$$
$$= 1.49 \times 10^{12} \text{ BTU's/year}$$

Therefore, during this 10-year period the amount of conserved energy from retrofitted structures required to satisfy the needs of the new structures built during the same period of time is:

$$\frac{1.49 \times 10^{12}}{5.7 \times 10^{12}} = 0.26 \text{ or } \underline{26\%}$$

At the end of 15 years this policy would result in a net savings in residential energy consumption of:

$$(8.57 \times 10^{12}) - (3.65 \times 10^{12}) = \underline{4.92 \times 10^{12} \text{ BTU's/year}}$$

Contra Costa County after providing for new housing units.

<u>Alternative D - C Plus Solar Water Heating</u>

1. 1975 - 1980

° Number of homes to be built is 20,330

° Number of homes retrofitted is 53,350

° Energy saved through retrofitting of 53,350 existing homes assuming a 48% reduction in energy consumption is:

$$= (5.335 \times 10^{4} \text{ homes}) (1.456 \times 10^{8} \text{ BTU's/home/year}) (.48)$$

$$\underline{= 3.73 \times 10^{12} \text{ BTU's/year}}$$

° Energy needed for new homes assuming the average size to be in the 3 to 4 bedroom range and also benefiting from the 48% reduction in energy needs is:

$$= (2.033 \times 10^{4} \text{ homes}) (2.87 \times 10^{8} \text{ BTU's/home/year}) (.48)$$

$$\underline{= 2.8 \times 10^{12} \text{ BTU's/year}}$$

Therefore, the amount of the conserved energy from retrofitted structures required to satisfy the needs of the new structures on a per year basis at the end of five years is:

$$\frac{2.8 \times 10^{12}}{4.27 \times 10^{12}} = .66 \text{ or } 66\%$$

2. 1980 - 1990

° Number of new homes to be built is 27,780

° Number of homes to be retrofitted is 106,700

° Energy saved through retrofitting of 106,700 existing houses assuming a 55% reduction in energy consumption is:

$$= (1.067 \times 10^{5} \text{ homes}) 91.456 \times 10^{8} \text{ BTU's/home/year}) (0.48)$$

$$\underline{= 7.46 \times 10^{12} \text{ BTU's/year}}$$

° Energy needed for new homes assuming the average size to be decreasing so that the cross-section approximates that existing in 1975, while also benefiting from a 55% reduction in energy is:

$$= (2.778 \times 10^{4} \text{ homes}) (1.456 \times 10^{8} \text{ BTU's/home/year}) (.48)$$

$$\underline{= 1.91 \times 10^{12} \text{ BTU's/year}}$$

Therefore, during the 10-year period the amount of conserved energy from retrofitting structures required to satisfy the needs of the new structures built during the same period of time is:

$$\frac{1.91 \times 10^{12}}{0.55 \times 10^{12}} = .29 \text{ or } \underline{29\%}$$

At the end of 10 years, this policy would result in a net savings in residential energy consumption of:

$$(12.82 \times 10^{12}) - (5.44 \times 10^{12}) = 7.38 \times 10^{12} \text{ BTU's/year}$$

in the County after taking the projected growth of new housing units into account.

If the estimates of energy conservation are correct, a substantial County-wide saving in residential energy consumption can be realized even with a continued increase in the number of housing units in the County.

APPENDIX C: LIFE-CYCLE COSTING

The importance of life-cycling costing is that it reveals all costs over the life of alternative systems, not merely first costs. Life-cycle costing has been criticized on the grounds that first costs are relatively certain, but that all costs, reduced to an annual costs basis, depend on many uncertainties, including utility rates, labor and lifetimes of alternative systems. Estimating the life of alternative systems is essential in costing. Without estimated useful life, a simple price-of-system comparison is misleading. In Table VI-7, Benefit/Cost Analysis, Solar Heating for Swimming Pools, the impact of estimated lifetimes of alternative systems is quite significant in the relative dollar benefits of the 3 systems.

The central problem in life-cycle costing is varying degrees of uncertainty in estimating the useful life of the system or the total costs associated with it. If both have a similar degree of uncertainty, then life-cycle costing is a valid concept. At present, future gas and electricity costs appear to have a greater degree of uncertainty than the estimated lifetime of the readily available technologically established solar systems analyzed in this report.

Gas and Electricity Costs.

In order to undertake economic feasibility analyses, it is essential to estimate future gas and electricity costs. This is a future uncertainty subject to many changing conditions, and is a topic of heated discussion among various agencies and interested groups. The cost rise estimates used in this report are probably as good as any other, but should not be taken as fact. The cost rise estimates used here are:

1977-1980	-	24% per year
1981-1987	-	12% per year
1988-2000	-	6% per year

Factors weighed in this estimate are:

1. Approximately a 40% per year rise over the last 2 years.

2. P.G.&E. short-term estimates to large customers of 30 to 35% per year rises for the next year or 2 years.

3. P.G.&E. belief that cost rises will level off at some future time.

4. PUC policy to restrain residential cost rises. (Two of the three life-cycle cost analyses are for residential uses.)

5. Cost of imported oil.

6. National and State policy to price gas as a depletable resource rather than as a service.

7. After 1987, costs will stabilize and rise at the general rate of inflation.

Any of these assumptions may be incorrect. Using a different set of cost-rise assumptions in life-cycle costing would yield different comparisons.

A study prepared for the ERCDC by the Stanford Research Institute uses 20% per year as the rate of increase. A representative of a local development association reported a belief that 10% per year is closer to reality. Others who wish to do life-cycle cost analyses should evaluate cost rises based on current information and on the power sources of the local utility. Hydroelectric generation will probably remain far less costly than new sources such as gassified coal or nuclear. Here, bottled gas costs 25% more than natural gas, and electricity costs 5 times as much as natural gas. The following examples refer only to natural gas as the fuel energy source.

LIFE CYCLE COSTING EXAMPLES

The Energy Study includes three approaches to life-cycle costing deemed appropriate to differing situations:

A. <u>Benefit/Cost Ratio</u> for alternative pool heating systems

B&C. <u>Payback Period</u> for alternative residential conservation programs plus a brief discussion of Cash Flow

D. <u>Present Value</u> for alternative space and water heating systems for larger institutional retrofit installations

A. Alternative Pool Heating Systems

This simplified procedure is suited to the analysis for the following reasons:

1. The investment is small.

2. Budgeting for O&M is not required. Most homeowners do their own maintenance.

3. The benfits so clearly accrue from any solar system as compared with gas that the issue is selecting a solar alternative, not selecting between solar and gas.

4. The Benefit/Cost Ratio is easy to understand and would have more meaning to prospective pool heater purchasers than a more complex analysis.

TABLE VI-7: BENEFITS AND COSTS OF SOLAR POOL HEATING, AVERAGE RESIDENTIAL SWIMMING POOL

Type of Heater	Estimated Life in Years	Initial Cost in Dollars	$ Savings in 2000 Therms of Gas From 1977 Over Life Span of Unit	Benefit Cost Ratio	B/C Ratio With 10% Tax Credit
Floating Plastic Wafers	3	300	1,500	5.1	NA
Low Efficiency Plastic	10	1,200	9,900	8.3:1	9.2:1
High Efficiency Collectors	20	2,000	31,000	15.5:1	17.2:1
Gas Pool Heater (Given for Comparison)	13	650	(Gas Cost) 14,998	NA	NA

The benefits so clearly outweigh the costs for all systems it was not deemed necessary to use a more sophisticated means of demonstrating feasibility. The 10% tax credit is presently available in California. The question may be academic if gas pool heater connections are disallowed. This casting method is described in Appendix C.

Source: Contra Costa County Planning Department. Cost data from solar companies

Because this particular analysis is aimed at the residential consumer, investment has not been discounted nor have gas cost rises been adjusted for inflation, so all dollars shown as they would appear on utility bills. No references in the literature to a cost analysis this simple have been observed.

Certain items of interest to the residential consumer are not included in the analysis. The first two solar systems are reported to provide water in the desirable range of 78-80 degrees during the "swimming season" of five months. Only the gas heater and high-efficiency solar heater can provide all-year swimming temperatures, and, for the solar system, a pool cover would also be required. Gas costs are based on an estimated use of 2,000 Therms annually for the five-month swimming season. This analysis confirms the widely accepted idea that solar water heating is cost-effective today, and will pay back its cost in 1 to 8 years.

B. Payback Period, Residential Conservation Alternatives

This procedure was developed for the Energy Study, but it is similar to cost procedures outlined in energy references. The Payback Period is defined as the time required for cumulative utility savings to equal the present value of the initial investment discounted at 9%. The procedure is suited to life-cycle costing for new residential development for the following reasons:

1. The intent is to have general applicability to aid decision makers to determine appropriate levels of conservation in new residential development. Any individual building would vary somewhat, but conventional mass housing is standardized enough for these generalizations to have applicability.

2. Initial costs are discounted at 9% annually, and utility cost increases are adjusted downward 6% on order to present a more accurate measure of the real cost and value of money in the future. This is partially because of the larger investment for some alternatives, because the value of money is more relevant in the longer payback periods of some of the alternatives, and because this analysis is intended to meet the needs of developers and other decision makers whose decisions would affect tens or hundreds of buildings and involve large total initial costs.

3. System lifetimes are not included. Some items in the conservation packages would have lifetimes as long as the building (insulation), and some would not (energy-efficient appliances). Also, there is no long-term experience with items such as pilotless ignition furnaces which would indicate whether their lifetimes or maintenance costs differ from conventional furnaces with pilots. For these reasons, lifetimes and O&M costs have been disregarded.

APPENDIX C

In order to use this procedure, it is necessary to estimate the following:

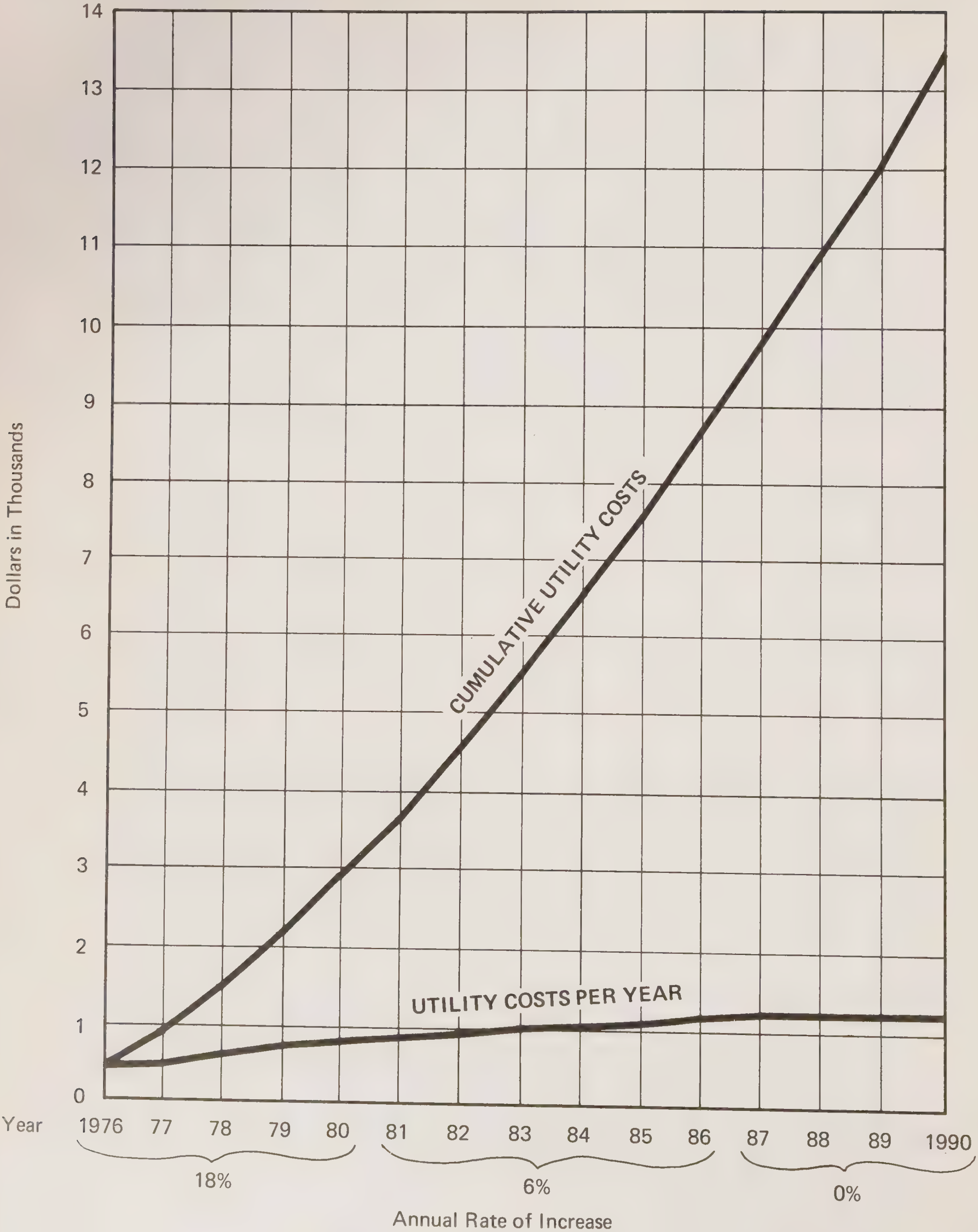
1. Utility cost rises. Those used in this study are described above.

2. Average residential gas and electricity costs and breakdown by type of use. Estimates used in this analysis are based on figures made available to the study by PG&E.

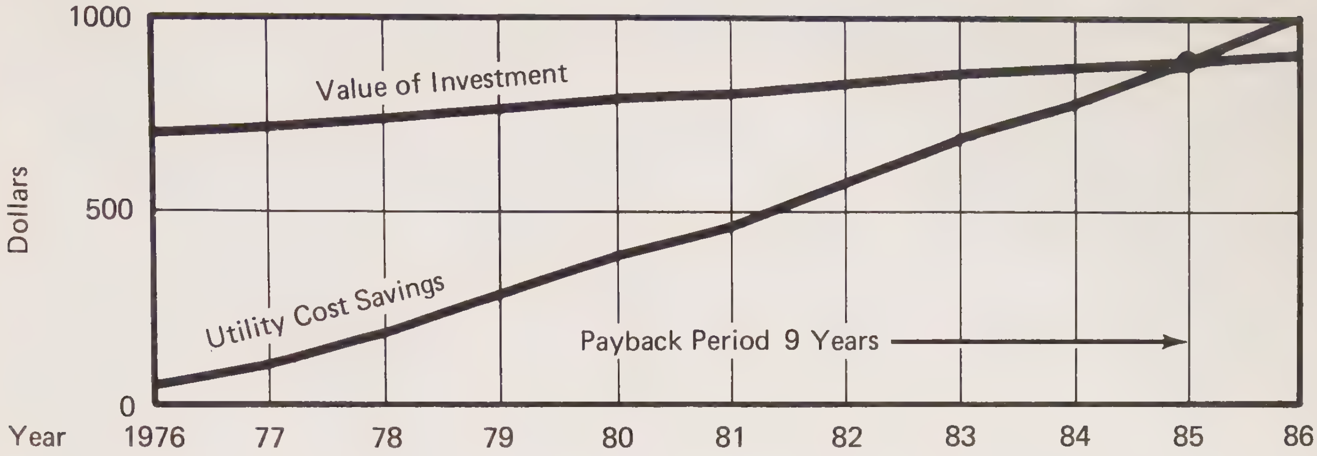
3. Estimates of initial cost and conservation values of conservation features. The initial cost estimates used in this Study were derived from information provided by the Consultant (solar), P.G.&E. (insulation, pilots), and various reports and newspaper articles. In all cases, thought must be given to the local climate and types of buildings. Conservation values in this analysis reflect the relatively warm winter temperatures experienced in Contra Costa County and apply to our typical single family detached dwellings. Insulation to State standards in a cold climate could have a higher conservation value, and insulation of apartment buildings a lower conservation value, both reflected in utility cost savings.

Tables VI-2 through VI-6, reproduced here from Section VI, are graphic summaries of the process. One calculation sheet is included as an illustration for others who wish to use this procedure. See Table A.

Appendix C
Table VI-2 ALTERNATIVE A Investment: None
Conservation: None

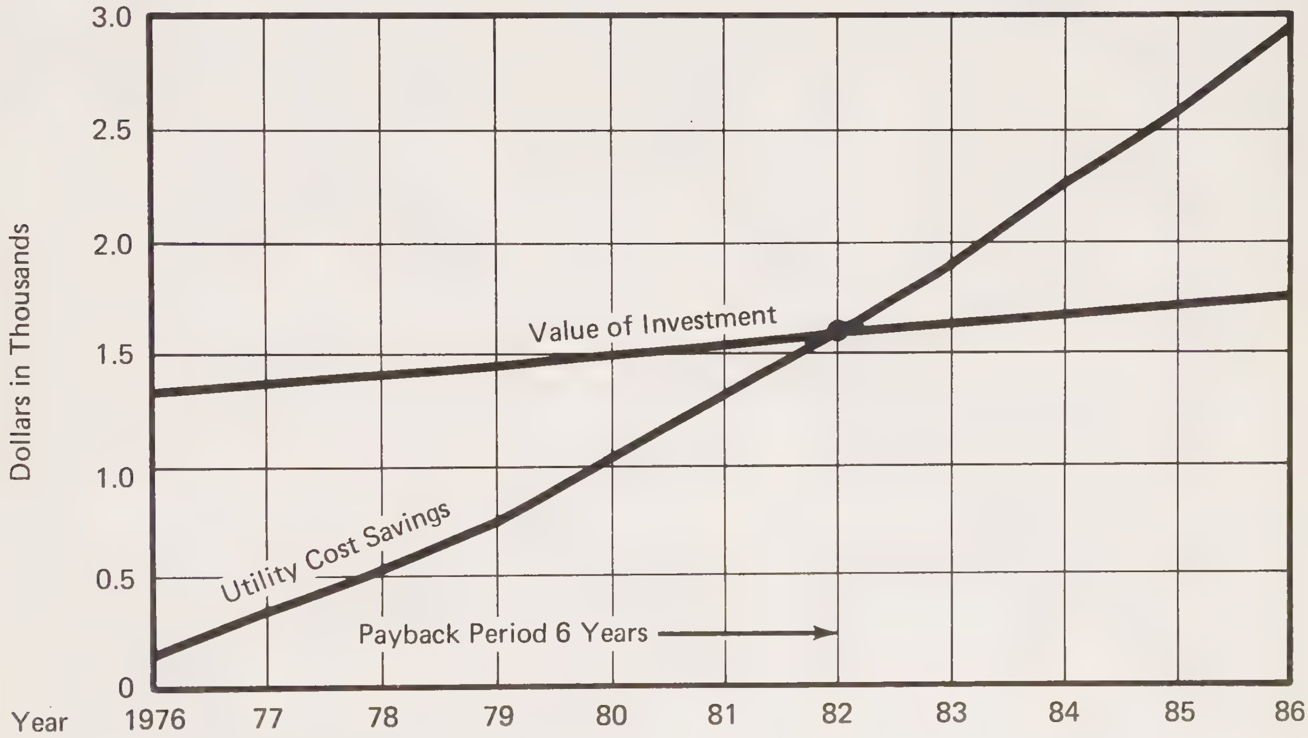


Appendix C
Table VI-3 ALTERNATIVE B



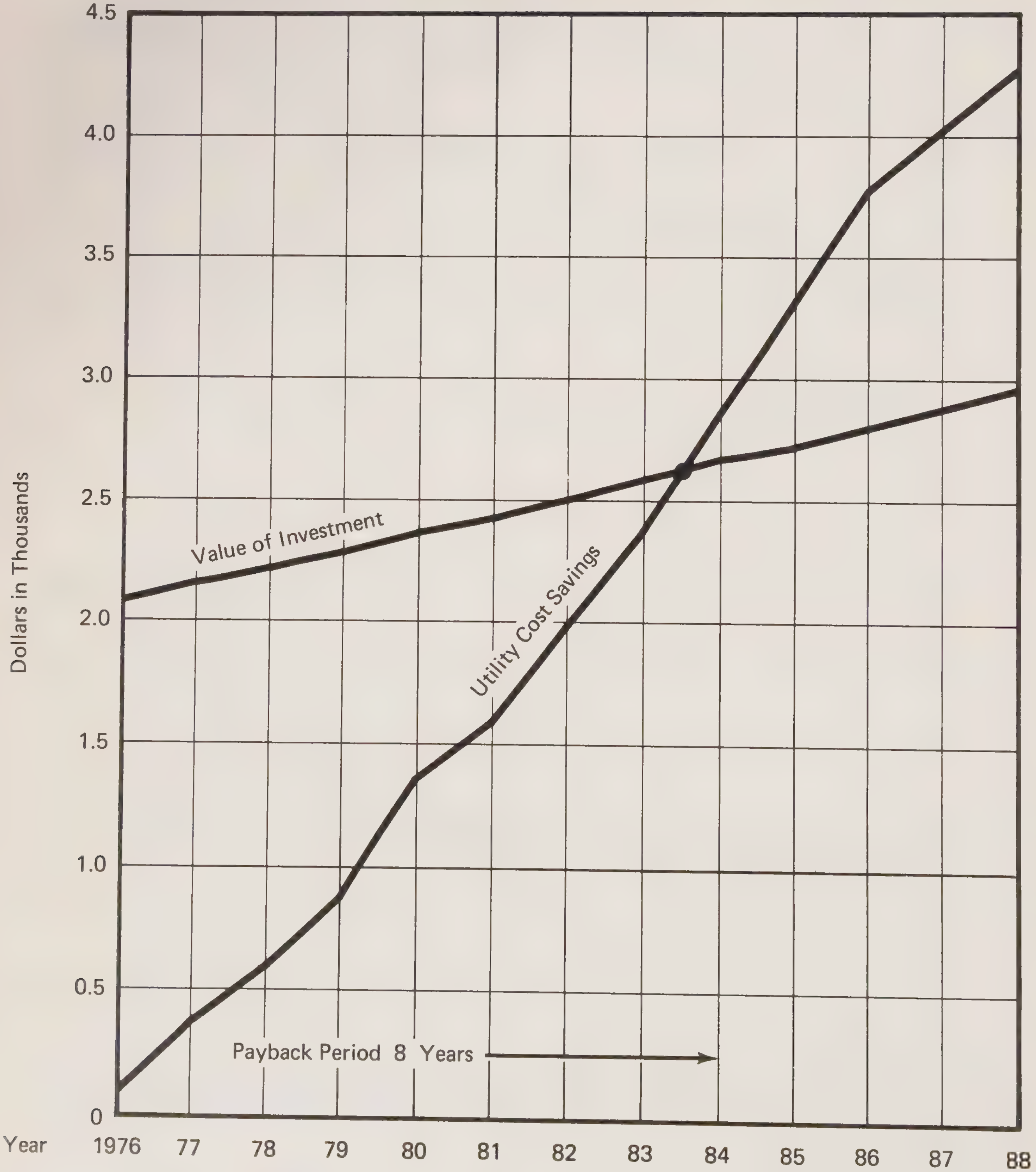
Investment: $700
Conservation: 17% of A
(State Standards for insulation and glazing)
Payback Period: 9 Years

Table VI-4 ALTERNATIVE C



Investment: $1300
Conservation: 37% of A
(Alt. B plus additional features)
Payback Period: 6 Years

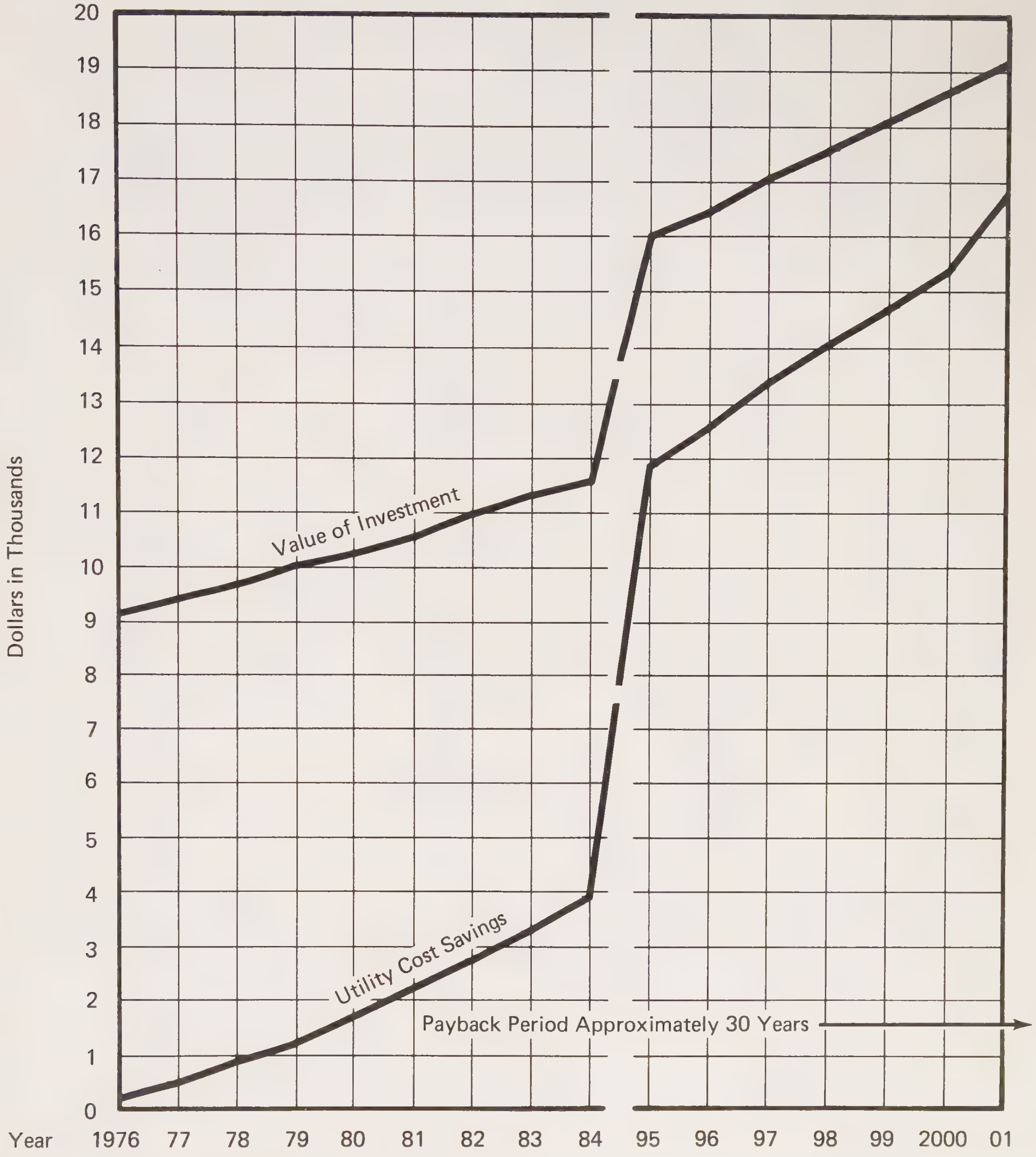
Appendix C
Table VI-5 ALTERNATIVE D



Investment: $2100
Conservation: 48% of A
(Alt. C plus solar water heating)
Payback Period: 8 Years

Appendix C

Table VI-6 ALTERNATIVE E



Investment: $9300
Conservation: 77% of A
(Alt.C plus solar water heating,
space heating and cooling)
Payback Period: 30 Years

TABLE A. WORKSHEET FOR RESIDENTIAL ALTERNATIVE D
(Alternative C + Solar Water Heating)

Year	Alternative A No Conservation		Alternative D Saves 55% of A		Value $2100 of Investment	Year
	Annual Cost of Utilities	Cumulative Cost	Annual Savings	Cumulative Savings		
1976	$ 405	$ 405	$ 223	$ 223	$2100	1976
1977	477	882	262	485	2163	1977
1978	606	1488	333	818	2228	1978
1979	716	2204	394	1212	2295	1979
1980	802	3006	441	1653	2364	1980
1981	848	3854	466	2119	2435	1981
1982	893	4747	491	2610	2508 *	1982
1983	946	5693	520	3130	2582	1983
1984	998	6691	549	3679	2660	1984
1985	1050	7741	578	4257	2740	1985

* In approximately 6 years, cummulated savings exceed opportunity cost of the initial investment. Thus, the payback period is 6 years.

C. Payback Period, Alternative E With Economic Incentives

The method used to compare the benefits of economic incentives is similar except that the meaning of the Value of Investment column is different, whereas in Alternatives B through E, the Value of Investment column represents the opporuunity cost of the initial amount if invested at 9%; in incentives examples the Cost of Loan column represents actual loan payments. In Alternative F, 10% tax credit, the interest is calculated at 9.6%, the FHA home improvements loan rate, and for Alternatives G and H, the interest is calculated at 6%. Legislation enabling the State to provide low interest loans for energy conservation home improvements has been passed and may be in effect in 1977 if the November 1976 bond issue passes. A 6% interest rate was arbitrarily chosen for this incentive, and was calculated for 2 loan periods: 10 years and 20 years. A summary calculation sheet is included. See Table B. Graphs are not included.

Appendix C

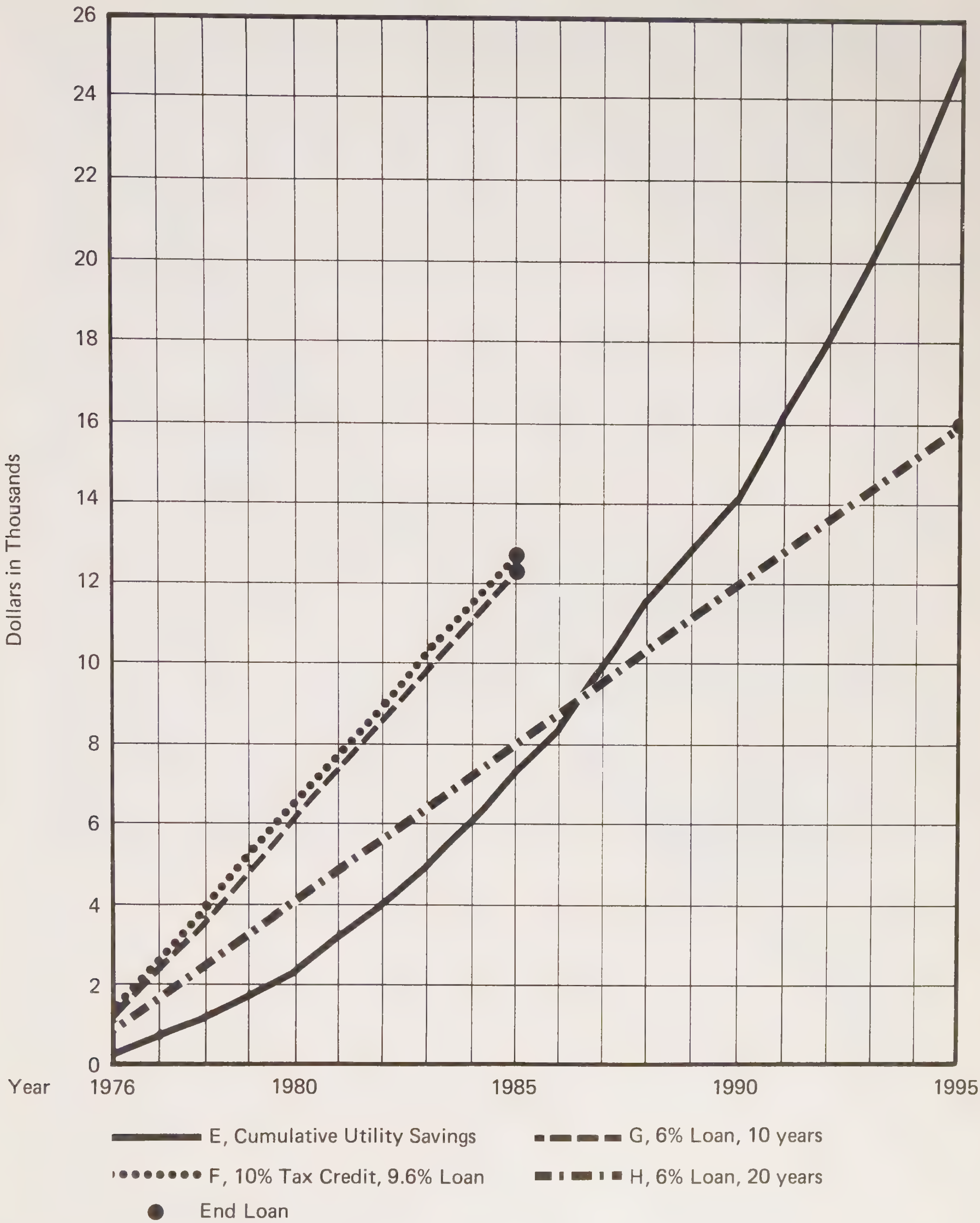
TABLE B. CALCULATION SHEET, ALTERNATIVES F, G, H.

Year	Alternative E Cumulative Savings	F Cumulative Cost $8,500 at 9.6%,10 Yrs.	G $9,300 at 6%,10 Yrs.	H $9,300 at 6%,20 Yrs
1976	312	1,326	1,240	800
1977	698	2,652	2,480	1,600
1978	1,177	3,978	3,720	2,400
1979	1,772	5,304	4,960	3,200
1980	2,438	6,630	6,200	4,000
1981	3,183	7,866	7,440	4,800
1982	4,015	9,102	8,680	5,600
1983	4,954	10,338	9,920	6,400
1984	6,002	11,574	11,160	7,200
1985	7,176	12,810	12,400	8,000
1986	8,490	End Loan	End Loan	8,800
1987	9,883			9,600
1988	11,360 F & G)13 + Year Paybacks			10,400
1989	12,925			11,200
1990	14,200 H - 15+)Year Paybacks			12,000
1991	16,343			12,800
1992	18,207			13,600
1993	20,184			14,400
1994	22,279			15,200
1995	24,496			16,000
1996	26,854			End Loan
1997	29,349			
1998	31,994			

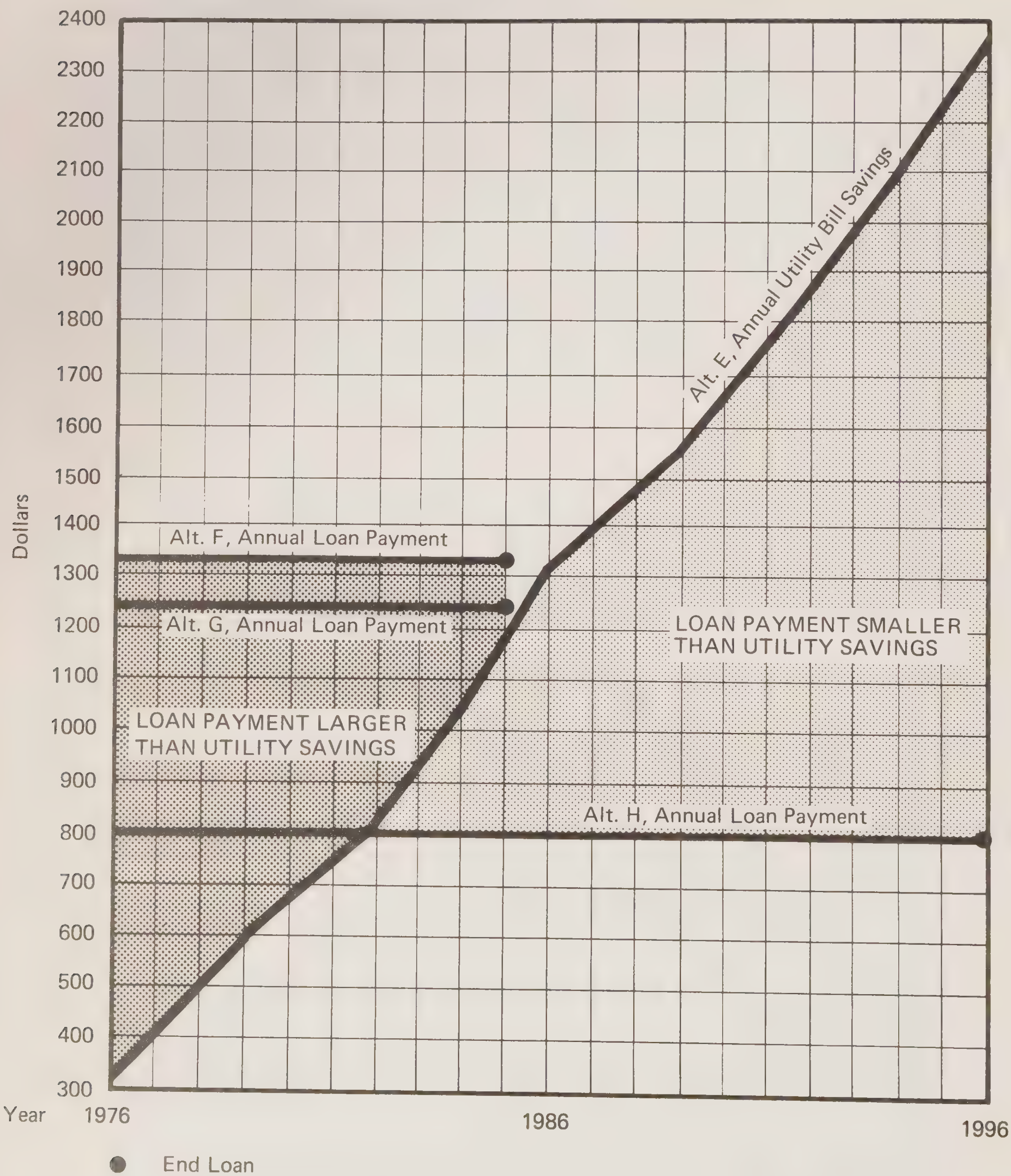
Annual Cash Flow

To the homeowner considering a conservation investment, cash flow may appear more important than life-cycle costs. Although the life-cycles of Alternatives F and G demonstrate a shorter period of time in which total utility bill savings would equal the cost of the loan, the cash flow for Alternative H is more attractive. As can be seen from Table C, Summary Graph, and from Table D, Annual Cash Flow, annual utility bill savings would be greater than the annual loan payment after the sixth year for the 20-year loan, alternative H. In Alternatives F and G, the loan payment is always greater than the utility bill savings, but after 10 or 11 years, all of the utility savings are free and clear. Thus, the relative value of an incentive depends on the perceptions and needs of individuals. The Payback Period and Annual Cash Flow methods should not be used for large apartment complexes, commercial, industrial or institutional life-cycle costing since they do not include cost factors relevant to uses other than a single residence.

Appendix C
Table C SUMMARY GRAPH, ALTERNATIVES F, G, H



Appendix C
Table D ANNUAL CASH FLOW



D: Present Value System. Retrofit of Larger Institutional Buildings

Selected County buildings were anlyzed for their energy use as a part of this Study. Two buildings were selected for life-cycle costing as examples of retrofit costs and performance in non-residential buildings, Tables VI-8 and VI-9.

The life-cycle, discount factors and future utility costs were selected by Contra Costa County Planning Department staff to conform with other analyses in this report. System operating characteristics and costs were supplied by Interactive Resources, Inc., the Energy Study Consultant.

Life-cycle costing involves projecting costs and benefits of alternate courses of action for a specific period of time. This time period may be chosen to reflect:

1. The mission life, or period over which a need for the asset is anticipated;
2. The ownership life, or period during which the benefits and costs will flow to the entity for which the analysis is being performed;
3. The physical life, or period over which the asset may be expected to last physically; and
4. The technological life, or period before obsolescence would dictate replacement of the existing or prospective asset.

Similarities among alternatives with equal economic consequences are ignored. Only the differences are significant.

The time value of money varies for different people or agencies according to the rate of return normally available to them for capital investments. Most Federal government guidelines specify a ten percent opportunity cost. Investment opportunities in the private sector vary with risk, time, and liquidity, but can be measured by the market in such indices as savings accounts, prime rates, and AAA bonds. The time value of money, or opportunity cost, is usually expressed as rate of interest and includes a factor for inflation. Applied to life-cycle analysis, this interest rate becomes a discount factor and is used to calculate a present value of both positive and negative future cash flows.

$$\text{Present value} = F \times 1/(1+i)^n$$

Where:

F = A future sum of money at the end of n periods of time at an interest i.

i = An interest rate.

n = Number of interest periods.

TABLE VI-8: SOLAR WATER HEATING, RETROFIT OF BUILDING A

LIFE CYCLE COST ANALYSIS
EXISTING GAS-FIRED DOMESTIC HOT WATER HEATING

Year[1]	System Cost[2]	Fuel Cost[3]	Salvage Value[4]	Subtotal Present Value[5]
0	(none)			
1		22,800		20,976
2		27,550		23,142
3		33,250		25,602
4		39,900		28,329
5		48,450		31,492
6		57,950		34,770
7		69,350		38,142
8		84,550		42,275
9		88,350		40,641
10		84,550		35,511
11		98,880		38,532
12		105,450		37,962
13		111,150		36,679
14		117,800		35,340
15		125,400		33,858
16		133,000		33,250
17		140,600		32,338
18		149,150		31,321
19		158,650		30,143
20		167,200		30,096
				660,399

[1]Twenty years approximates the projected service life of solar heating equipment used for comparison. Year 1 is 1978 since implementation would take approximately 24 months including decision-making, design, and construction.

[2]The gas-fired equipment is existing so there is no system cost. Since it would serve as a back-up for solar heating, maintenance and replacement would be required in any case.

[3]Fuel costs are computed at $.17 per therm for 1976, and inflated 20 per cent per year for the next ten years, and 6 per cent per year thereafter. Year 1 is assumed to be 1978.

[4]Any salvage value of conventional equipment would also apply to the solar heating analysis and is, therefore, irrelevant.

[5]Yearly cash flows are discounted at 9 per cent compounded annually.

Source: Energy Study, Vol. III.

LIFE CYCLE COST ANALYSIS
SOLAR-AUGMENTED SPACE AND WATER HEATING

Year[1]	System Cost[2]	Fuel Cost[3]	Salvage Value[4]	Subtotal Present Value[5]
0	(300,000)			(300,000)
1		2,280		2,098
2		2,755		2,314
3		3,325		2,560
4		3,990		2,833
5		4,845		3,149
6		5,795		3,477
7		6,935		3,814
8		8,455		4,227
9		8,835		4,064
10		8,455		3,551
11		9,880		3,853
12		10,545		3,796
13		11,115		3,668
14		11,780		3,534
15		12,540		3,386
16		13,300		3,325
17		14,060		3,234
18		14,915		3,132
19		15,865		3,014
20		16,720		3,010
				366,039

[1]Twenty years approximates the service life of solar heating equipment. Year 1 is 1978 since implementation would take approximately 24 months including decision-making, design, and construction.

[2]Due to the retrofit nature of such a system, the cost is necessarily a rough estimate and includes collectors, support structures, transfer systems, controls and additional storage. Solar maintenance costs were considered to be approximately equal to the savings on conventional equipment due to a 90% reduction in operating load.

[3]Fuel projections for the gas-fired equipment used in the back-up mode are approximately ten per cent of the total existing yearly load. Costs are computed at $.17 per therm for 1976, and inflated 20 per cent per year for the next ten years, and six per cent per year thereafter.

[4]The solar heating equipment is projected to be completely depreciated after 20 years.

[5]Yearly cash flows are discounted at 9 per cent compounded annually.

TABLE VI-9: SOLAR SPACE AND WATER HEATING, RETROFIT OF BUILDING B

LIFE CYCLE COST ANALYSIS
EXISTING GAS-FIRED SPACE AND WATER HEATING

Year[1]	System Cost[2]	Fuel Cost[3]	Salvage Value[4]	Subtotal Present Value[5]
0				
1		1,032		949
2		1,247		1,047
3		1,505		1,159
4		1,806		1,282
5		2,193		1,425
6		2,623		1,574
7		3,139		1,726
8		3,927		1,913
9		3,999		1,840
10		4,257		1,788
11		4,472		1,744
12		4,773		1,718
13		5,031		1,660
14		5,332		1,600
15		5,676		1,533
16		6,020		1,505
17		6,364		1,464
18		6,751		1,418
19		7,181		1,364
20		7,568		1,362
				30,071

[1]Twenty years approximates the service life of solar heating equipment used for comparison. Year 1 is 1978 since implementation of solar devices would take approximately 24 months including decision-making, design, and construction.

[2]The gas-fired equipment is existing so there is no system cost. Since it would serve as a back-up for solar heating, maintenance or replacement would be required in any case.

[3]Fuel costs are computed at $.17 per therm for 1976, and inflated 20 per cent per year for the next ten years, and 6 per cent per year thereafter. Year 1 is assumed to be 1978.

[4]Any salvage value of conventional equipment would be likewise applicable to the solar augmentation analysis and is, therefore, irrelevant.

[5]Yearly cash flows are discounted at 9 per cent compounded annually.

Source: Energy Study Volume III

LIFE CYCLE COST ANALYSIS
SOLAR-AUGMENTED DOMESTIC HOT WATER HEATING

Year[1]	System Cost[2]	Fuel Cost[3]	Salvage Value[4]	Subtotal Present Value[5]
0	13,000			13,000
1		464		427
2		561		471
3		677		521
4		813		577
5		987		642
6		1,180		708
7		1,413		777
8		1,722		861
9		1,800		828
10		1,916		805
11		2,012		785
12		2,148		773
13		2,264		747
14		2,399		720
15		2,554		690
16		2,709		677
17		2,864		659
18		3,038		638
19		3,231		614
20		3,406		613
				26,533

[1]Twenty years approximatelys the service life of solar heating equipment. Year 1 is 1978 since implementation would take approximately 24 months including decision-making, design, and construction.

[2]Due to the retrofit nature of such a system, the cost is necessarily a rough estimate and includes collectors, support structures, transfer systems, controls and additional storage. Solar maintenance costs were considered to be approximately equal to the savings on conventional equipment due to a 90% reduction in operating load.

[3]Fuel projections for the gas-fired equipment used in the back-up mode are approximately 45 per cent of the total existing yearly load. Costs are computed at $.17 per therm for 1976 and inflated 20 per cent per year for the next 10 years and 6 per cent per year thereafter.

[4]The solar heating equipment is projected to be totally depreciated after 20 years.

[5]Yearly cash flows are discounted at 9 per cent compounded annually.

The following sources discuss life-cycle costing:

C. W. Griffin. Energy Conservation in Buildings: Techniques for Economical Design.

The Construction Specifications Institute, Inc., 1150 Seventeenth Street, N.W., Washington, D.C. 20038. 1974. C.C.C. Number: 74-18630

Rosalie T. Ruegg. Solar Heating & Cooling in Buildings: Methods of Economic Evaluation.

U. S. Department of Commerce, National Bureau of Standards. COM-75-11070. July 1975. Distributed by National Technical Information Service, U.S. Department of Commerce, Springfield, Va. 22151.

This process may be unnecessarily cumbersome and less suited to local government office use. Requires a computer. Critical review of payback method and present value method.

U.S. Department of Commerce. Total Energy Management. A Practical Handbook on Energy Conservation and Management.

Jointly with the National Electrical Manufacturers Association (NEMA), and National Electrical Contractors Association (NECA). First Edition. December 1975. Distributed through Department of Commerce District office.

The handbook and costing procedures are designed for use by owners and managers of office buildings and small retail stores. Incomes operation and maintenance costs in Payback Period analysis.

During preparation of the Contra Costa County Energy Resource and Conservation Study, the proposed Environmental Impact Report Energy Conservation Guidelines, Appendix F, prepared by the Office of Planning and Research, were reviewed, and has led to general observations on Appendix F plus recommended specific changes.

General Observations

1. Appendix F is an approach to land development or redevelopment projects. It should be made clear that other types of projects may require other formats. Non-development projects include disposal of public land and property, district annexations, school closure, public safety programs, and pesticide applications, to name a few. The proposed revisions to Appendix F apply only to development projects.

2. In keeping with the Resources Agency interest in simplifying CEQA processes, and given the range and complexity of projects in the State, one set of detailed guidelines intended to cover all projects would be cumbersome, lead to confusion, and could actually hamper the discovery and disclosure of energy impacts uniquely associated with a specific project. The more flexible the EIR guidelines, the more relevant the Energy Section is likely to be.

3. Item II of Appendix F recommends the standardization of energy measurement units, specifically the BTU. Comparative analysis does require a standard unit, but since it is national policy to convert to calories and joules as part of a general metric conversion, this would appear to be an advantageous time to being using metric measurements in the EIR. Equivalents can be given to and popular understanding during the period of conversion. This report consistently converts to BTU, in keeping with current policy, and where numbers are so high they may be meaningless to most persons, a conversion to barrels of oil is given. Barrels of oil is particularly relevant in Contra Costa County because so much oil is burned here to generate electricity. The idea is to standardize for comparison and use or easily understood measurement. The same concept could be recommended by the State, using Keal and BTU. An aid to metric conversion would be to have all State-prepared documents using the desirable units of measurements.

Proposed Revision to Appendix F

These proposals, beginning with Item III-1 of Appendix F, are based on experience and project analysis practice during the course of the Energy Study. They are designed to reveal energy use and mitigation measures of a land development project or land planning project, with some items such as efficient equipment and energy in buildings, more related to a development project.

III. 1. Project Description

A. Identify energy consuming processes and equipment for construction, operation, and/or removal;

B. Identify energy conservation equipment and design features;

C. Provide these items in terms of initial and life-cycle energy costs or supplies.

2. Environmental Setting

A. Inventory of existing energy sources by fuel type
B. Inventory of existing energy uses by fuel type
C. Identification of climate factors such as winter winds, summer ventilation, solar insolation and heating and cooling degree days which could affect project energy use
D. Discussion of off-site relationships, e.g. distance to residential areas, schools, shopping, parks, raw materials supplies, and employment centers which could affect long-term energy use for transportation

3. Environmental Impacts

A. Energy requirements and efficiencies by amount and fuel type and initial versus long-term costs over project life cycle time for construction, operation, maintenance and/or removal:

1. Buildings
2. Streets and roads
3. Utilities, street lights, pumping of water and/or sewage
4. Storm drainage facilities
5. Landscaping
6. Transportation

B. Effects on energy source: local and regional
C. Effects on energy use including peak hourly and/or seasonal demands
D. Provide these items as basic information and delineate the difference between the energy pictures without the proposed project and with the proposed project

4. Unavoidable Adverse Impact: Net Energy Demand: Construction, Operation, Maintenance, and/or Removal

5. Mitigation Measures (Including but not limited to)

A. Project design

1. Site preparation, e.g., eliminate unnecessary grading reduce street length, and areas of paved surfaces, shorten drainage and utility lines, maintain natural drainage channels

2. Climate considerations, e.g., lot and building orientation, shading of buildings, glazing, insulation, solar energy capabilities, cold ponding areas
3. Energy efficient mechanical system and appliances
4. Alternative fuels or energy systems
5. Design of potential retrofit efforts
6. Recycling and self-sufficiency
7. Utilization of waste heat and materials
8. Development of total systems concepts to reduce wasteful and inefficient production processes and facility system operations; e.g., solar considerations no plant and process design, materials handling and storage, fuel shaving considerations, energy transmission and conversion improvements, insulation, process steam. Space heating and air conditioning, degree to which labor is to be substitued for energy consuming equipment

B. Consideration of peak hour and peak season restrictions
C. Allocation of petroleum products
D. Encourage energy conservation in transportation

6. Alternatives, evaluate energy consumption for project alternatives, e.g., cluster development or planned development

7. Short-term gains versus long-term impacts: short-term energy benefits as opposed to effects on long-term energy sources and fuel types, effects of rising fuel costs

8. Irreversible commitment of resources, use of non-renewable resources during construction and maintenance and operation

9. Growth inducement: effect on primary energy sources and distribution systems

GLOSSARY OF TERMS AND UNITS OF ENERGY

GLOSSARY OF TERMS

Cooling Degree Days. A measure of annual cooling needs based on time plus the difference between the mean daily outdoor temperature and 65 degrees Farenheit. Example: 75 F mean temperature -65 F = 10 Cooling Degree Days for that day.

Energy Efficiency Ratio. (EER) The ratio in BTU's output to total input in watts. The higher the ratio, the more efficient the unit.

Glazing. Glass wall areas. May be openable or not.

Heat Gain. Capacity of materials to transmit heat to building interior.

Heat Loss. Capacity of materials to transmit heat to building exterior.

Heating Degree Days. A measure of annual heating needs based on time plus the difference between 65 degrees Farenheit and the mean daily temperature. Example: 65 F - 55 F = 10 Heating Degree Days for that day.

HVAC - Heating ventilating and air conditioning systems within or associated with a building.

Peak Demand. A daily or annual high-use period. For electricity the seasonal peak demand occurs during the summer when air conditioning is used, and daily during the 5 to 7 p.m. period when home energy use is at its highest.

Pilotless Ignition. Same as Intermittant Ignition device. Any ignition system on a gas appliance which is not a continuously burning gas pilot light.

Retrofit. Supply with new equipment, parts, or features after completion of building construction.

Temperature Inversion. An atmospheric condition in which warmer air lies above cooler air. This condition occurs in the Bay Area approximately two days out of three, and at elevations of 1,500 to 3,000 feet. Prevailing winds continue above the inversion but are inhibited beneath it.

UNITS OF ENERGY

1 joule (j) - energy required to lift 1 kilogram 10.2 centimeters (4 inches)

1 watt (w) -1joule per second

kilowatt (kw) - 1000 watts

kilowatt hour (kwh) - 1000 watts for 1 hour. A measure of accumulated energy usage. Equals 3,412 BTU - 860 Kcal

BTU - British Thermal Unit. The energy required to raise 1 pound of water from 59°F to 60°F. Equals 252 calories - 0.252 Kcal.

Therm - A heat value measure of gas equivalent to 100,000 BTU

Kilocalorie (Kcal) - The amount of heat required to raise the temperature of one kilogram of water one degree Celsius

Langley - A unit of solar radiation equivalent to one gram calorie per square centimeter of irradiated surface

Barrel of Crude Oil (Bbl.) - 40 gallons. Equals 5,800,000 BTU = 23,015,873 Kcal

ENERGY CONVERSION FACTORS

	BTU	KCAL	KWH	THERM
1 BTU =	1	0.252	0.000293	0.00001
1 Kcal =	3.9683	1	0.0011622	0.00003968
1 Kwh =	3412	859.184	1	0.003412
1 Therm -	100,000	25,200	29.3	1.

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